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A KINEMATIC UPGRADE TO AN INFRARED AIR-TO-AIR MISSILE USING DUAL-INTERRUPTED-THRUST TECHNOLOGY AND ITS EFFECT ON LETHALITY

by

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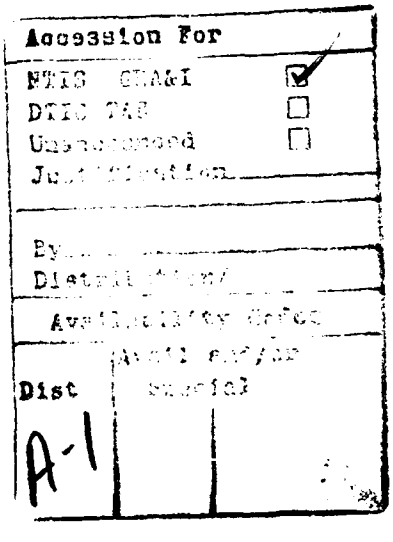
ABSTRACT

This study determines the increase in the kinematic performance and lethality of a generic Short-Range Air-to-Air Missile (SRAAM) due to the introduction of Dual-Interrupted-Thrust (DIT) technology to the missile motor. Data for the study was collected using the U.S. Air Force Trajectory Analysis Program (TRAP). The SRAAM modeled was similar in capability to the AIM-9 Sidewinder currently in U.S and Canadian Forces (CF) inventories. Quantification of kinematic performance was based on Performance Indices (PIs) which took into account range and time of flight constrained by a maximum miss distance (the lethal radius of the warhead) for seven selected scenarios. Comparison of missile lethality was based on the ratios of the distances between the outer and inner launch boundaries for the generic and modified SRAAMs. The results showed that DIT technology improves the kinematic performance and lethality of a SRAAM, provided the missile is not "seeker limited", i.e. the lethality benefits are greatest for rear aspect and shoot-up engagements.



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I. INTRODUCTION

A. BACKGROUND

The Canadian Forces (CF) are planning to procure advanced short and medium range air-to-air missiles to replace their existing stocks of AIM-9M Sidewinder and AIM-7M Sparrow missiles. Implementation of this project is currently scheduled for 2002. An alternative to the procurement of totally new missiles is to upgrade the missiles currently in inventory by improving their rocket motors to increase their kinematic performance and lethality against the latest generation of high performance aircraft.

Accordingly, Bristol Aerospace Ltd (BAL), in conjunction with the Defence Research Establishment Valcartier (DREV), has developed a high performance reduced-smoke composite propellant for use with the CRV7 2.75 inch rocket weapon system. BAL has proposed to use this high impulse propellant, in conjunction with Dual Interrupted Thrust (DIT) Technology, to retrofit the AIM-9M and AIM-7M missiles in order to improve their kinematic performance in terms of range, end-game maneuverability, and time-of-flight.

DIT technology refers to a change in the thrust profile of a solid rocket motor. Instead of a single burn, a solid rocket motor burn is interrupted and then restarted to yield a burn-coast-burn profile to increase its kinematic performance. The

pulse sizes and durations need to be optimized for the entire launch envelope, as well as the time delay between the pulses.

B. PURPOSE

The purpose of this study is to examine the feasibility of DIT technology when applied to a generic Short Range Air-to-Air Missile (SRAAM) similar in performance and capability to the AIM-9M Sidewinder, through target engagement modelling using the U.S. Air Force TRajectory Analysis Program (*TRAP*) [Ref. 1]. It will be used to determine the minimum and maximum launch ranges, time-of-flights (TOF's) and altitude differential between launch and target aricraft in specific scenarios to define the kinematic capabilities of the generic SRAAM with and without a DIT motor. (*TRAP* is explained in detail in Chapter II).

Criteria for determining missile lethality include the maximum and minimum launch ranges at which a successful intercept can occur, and kinematic performance will be assessed using a performance index based on launch ranges and the associated missile TOF.

II. OVERVIEW OF TRAP 3.1A

A. GENERAL SUMMARY

TRAP 3.1A is a general purpose TRajectory Analysis Program developed by the Foreign Science and Technology Center (FASTC). The source code with the test case is released by the Survivability/Vulnerability Information Analysis Center (SURVIAC). *TRAP* has the capability to simulate up to three vehicles in a given scenario, specifically the launch aircraft and target aircraft which may be either maneuvering or non-maneuvering, and the missile (a second target can be simulated to fly in formation with the first target). Either the launch platform or the target may be designated as ground based, allowing a multitude of engagement modelling. A typical air-to-air engagement is illustrated below in Figure 1.

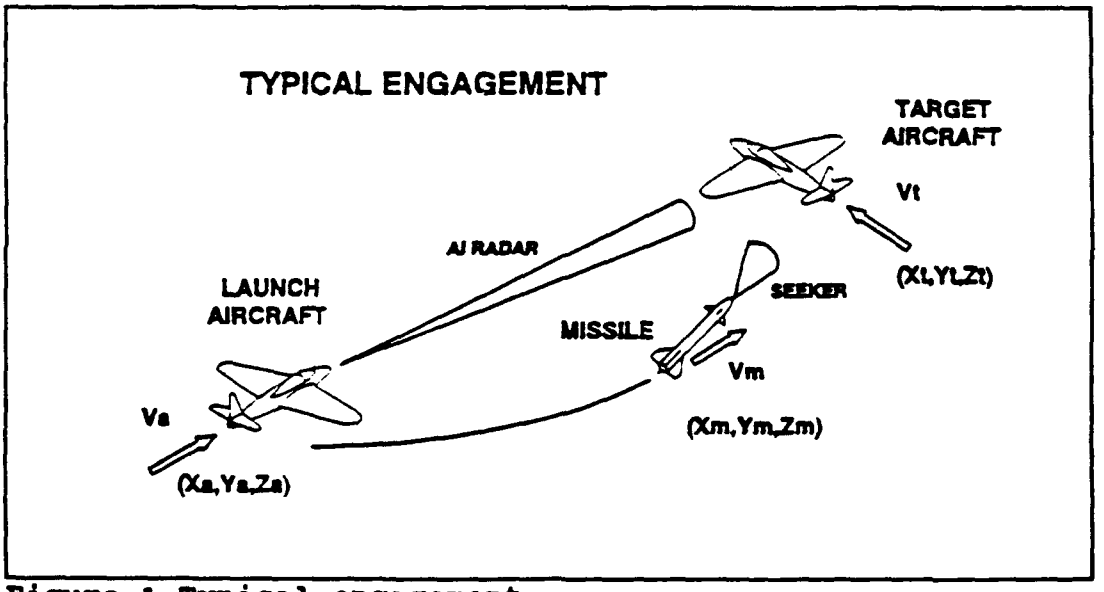

Figure 1 Typical engagement

In addition to simulating an individual engagement, *TRAP* has the capability to conduct multiple engagements and thereby determine the resulting missile launch envelopes for both maneuvering and non-maneuvering targets based upon a user defined miss distance. It can also perform missile performance reconstruction calculations given some observed parameters.

B. LAUNCH AIRCRAFT

The *TRAP* launch aircraft can be modelled as either a simplified or a modified point-mass model. Options also allow the launch "aircraft" to be stationary at ground level (i.e. modelling of a SAM site). If airborne, the launch aircraft may be programmed to fly pre-defined maneuvers as described in Subsection 2 below. The fidelity of the modelling depends on the amount of detail in the data files SACFT.DAT, SRADAR.DAT, and ACTBLE.DAT describing the launch aircraft. Complete listings of these files can be found in Appendix A. The detailed aircraft subsystems are described below.

1. Airborne Intercept (AI) Radar:

The AI radar on the launch aircraft tracks the target, and points the illuminator for a semi-active radar missile. A 'perfect' or a 'realistic' radar model may be selected. The 'realistic' AI radar model includes the effects of atmospheric losses, ground clutter, and fluctuating target signature.

2. Aircraft Guidance or Navigation

The launch aircraft guidance or navigation routine determines the flight path or maneuvers that it will follow during the engagement. Guidance can be either pre-programmed, or dynamic (i.e. pursuit trajectories), with maneuvers being initiated at the start of the engagement. Maneuvers available to the launch aircraft include: none, constant-altitude, level turn, turn to a specified heading or through a specified heading change (offset), constant-g (combined plane), and pursuit. Simplified pitch and roll dynamics are implemented in the models of the various maneuvers.

3. Aerodynamics

This section controls calculation of the aerodynamic forces. If the aircraft is modelled as a simplified point-mass, it has *no aerodynamics* and is constrained to fly straight and level. If modified point-mass is being used, the aircraft has aerodynamic and propulsive forces and will carry out the required maneuvers to its aerodynamic limits.

4. Mass Properties

No change in mass is modelled for the simplified point-mass simulations. For modified point-mass models, the mass decreases to reflect fuel flow and expending of ordnance.

5. Propulsion

The propulsion model calculates the thrust and flow rate for the aircraft only when it is modelled as a modified

point-mass. The thrust required is determined by the type of maneuver being executed.

6. Fire Control

The launch aircraft may be 'aimed' at the target at the start of the scenario. The aiming will be based upon computation of the optimum lead angle at the time of missile firing. If not aimed, the missile will still try to intercept the target as long as it is within the seeker field-of-view (FOV).

C. TARGET

The primary target is modelled similar to the launch aircraft. This vehicle may also be stationary (i.e. a ground target) or maneuverable with constant velocity or acceleration in any direction (to its aerodynamic limits). For modified point-mass simulations, the target may maneuver according to a series of pre-defined maneuvers similar to the launch aircraft modelling. A second target can be modelled in the simulation. It will follow a flight path offset from the primary target. Accuracy is determined by the detail of the inputs to the data files STARG.DAT and TGTBLE.DAT. Complete listings of these data files can be found in Appendix A. The detailed target subsystems are described below.

1. Guidance

The target aircraft guidance or navigation routine determines the flight-path that the target aircraft will

follow during the engagement. This guidance can be either preprogrammed or dynamic. Maneuvers available to the target are listed below in Table 1.

TABLE 1: SUMMARY OF TARGET MANEUVERS AVAILABLE

Routine Name	Maneuver Description
-	none
THEADG	level turn (to a heading)
TGNALT	maintain or change altitude
TGNGEE	constant 'g' (combined plane)
TSTURN	level wave or s-turn
TLDRAG	level drag (turn away from shooter)
TDDRAG	descending drag (turn away from shooter)
TLBEAM	level beam (turn to put shooter at 90°)
TSLICE	level slice (turn 90° at missile launch)
TOFFST	offset turn to a heading
TACCEL	change in Mach number
TGPURS	target pursuit of shooter
TTKOFF	climbout after takeoff
TLANDG	descent to landing

Maneuvers are initiated at a user specified time during the engagement, or at missile launch. The dynamic maneuvers

represent various defensive options for the target aircraft. Due to the inclusion of defensive maneuvers, the target aircraft has a wider range of maneuver options. Additionally, maneuvers can be combined to create more complex ones.

2. Aerodynamics

This routine controls the calculation of the aerodynamic forces. If the target is modelled as a simplified point-mass, it has no aerodynamics and is constrained to fly straight and level. If the modified point-mass is being used, the aircraft has aerodynamic and propulsive forces and will carry out maneuvers to its aerodynamic limits.

3. Mass Properties

No change in mass is modelled for the simplified point-mass simulations. For modified point-mass models, the mass decreases to reflect fuel flow.

4. Propulsion

The propulsion routine calculates the thrust and fuel flow rate for the aircraft if modelled as a modified point-mass. The thrust required is determined by the type of maneuver being executed.

5. Second Target

A second target aircraft may be modelled in the simulation, however it must be identical to the primary target. This is because it uses the same data files as the primary target. The second target's flight path is determined

by the flight path of the primary target and the user specified offset between the two targets. Depending upon the maneuver, the axial offset is determined as either a time delay with appropriate lateral and vertical offset, or a fixed spatial offset with identical maneuvering for the primary and secondary targets.

D. MISSILE

The *TRAP* missile can be simulated as a modified point-mass system or in 3-,5-, or 6-degree of freedom (DOF) detail. Modified point-mass (or pseudo 5-DOF) differs from 3-,5-, or 6-DOF simulations in that it does not use moment equations in the calculation of angular accelerations. For 3-DOF-PITCH models, the rate-of-change of angle-of-sideslip (β) is set to zero. For 3-DOF-YAW models, the rate-of-change of angle-of-attack (α) is set to zero. For 5-DOF models, the missile is constrained to fly at zero body roll angle. For 6-DOF models, angular accelerations about all three body axes are calculated from the moment equations. For the modified point-mass simula ions, no autopilot is modelled. For the 3-,5-,and 6-DOF simulations, the entire control system is modelled in detail. The detailed missile subsystems are described below and are defined in data files. The specific missile used in this study is described in Chapter III.

1. Seeker

This is a simple or detailed gimballed antenna tracking loop with optional infrared (IR) or Radio-frequency (RF) target signature computation. The seeker platform mechanical tracking process can be estimated by a series of filters or modelled in detail if desired. A simplified model is used for irradiance computations on IR seekers, but detailed modelling of missile radars is available. Radar seekers which can be modelled include fully active, semi-active, or passive types.

2. Guidance

Various guidance schemes can be modelled. Seeker parameters or command inputs are processed into vertical and horizontal guidance commands. The guidance schemes available in *TRAP* include PKL (pseudo-kinematic link), proportional navigation (generating either a rate or acceleration command), and pursuit. There are a series of preprogrammed or command guidance schemes including constant altitude, constant flight path, and constant-g which do not require the presence of a target.

3. Control System

This consists of the controller, autopilot and actuator. The controller takes the output from the guidance scheme and generates acceleration commands in pitch and/or yaw for point-mass simulations, or pitch and/or yaw autopilot

commands for 3-,5-,or 6-DOF simulations. The autopilot converts autopilot commands to a control-surface actuator demand for 3-,5-, and 6-DOF simulations. The dynamics of the body mounted sensors in the inner and outer loops of the autopilot are modelled (e.g. acceleration autopilot with body-rate feedback). The actuator converts actuator commands to actual control surface deflections for the 3-, 5-, and 6-DOF models. Missiles may be either aerodynamically controlled by the deflection of canards, wings or tail, or thrust vector controlled by the deflection of a gimballed nozzle.

4. Aerodynamics

This routine controls the calculation of the aerodynamic force coefficients for all simulations and moment coefficients for 3-, 5-, and 6-DOF simulations. For point-mass simulations, the lateral accelerations demanded by the autopilot controller (from output of the guidance scheme) are converted directly into the required angle of attack or angle of sideslip to meet these demands subject to the maximum angular limits. For both point-mass and 3-, 5-, or 6-DOF simulations, aerodynamic characteristics will be calculated up to the limits specified by the data input.

5. Mass Properties

Mass properties are calculated for initial, burnout and time-varying conditions. For point-mass simulations, only the change in missile mass is modelled. For 3-, 5-, and 6-DOF

simulations, the change in missile mass, center-of-gravity location, and principal moments of inertia are also calculated.

6. Propulsion

This routine calculates the thrust and fuel flow rate for the missile. A number of different propulsion systems can be modelled, including constant vacuum thrust, time varying vacuum thrust, constant throttle turbine engine, constant vacuum in tandem with constant throttle turbine, thrust to match time varying axial acceleration, variable throttle turbine engine (to maintain cruise Mach number), and variable throttle ramjet (to maintain cruise Mach number).

7. Simulation

For modified point-mass simulations, *TRAP* calculates the *instantaneous angle-of-attack* and sideslip that the missile will need to generate the required accelerations subject to a maximum rate of change specified by the user representing the missile's agility. This technique allows synthetic body rates to be generated that allow a detailed seeker model to be coupled to a point-mass airframe system.

For the more detailed 3-,5-, and 6-DOF simulations, the missile control system components are modelled as accurately as the user desires, and fin deflections are passed to the aerodynamics routine for the computation of forces and moments on the missile body.

E. MISSILE LAUNCH ENVELOPES

A very useful method of visualizing the capabilities of a missile is its launch envelope. Figure 2 is an example of a launch envelope for a typical SRAAM employed against a non-maneuvering target.

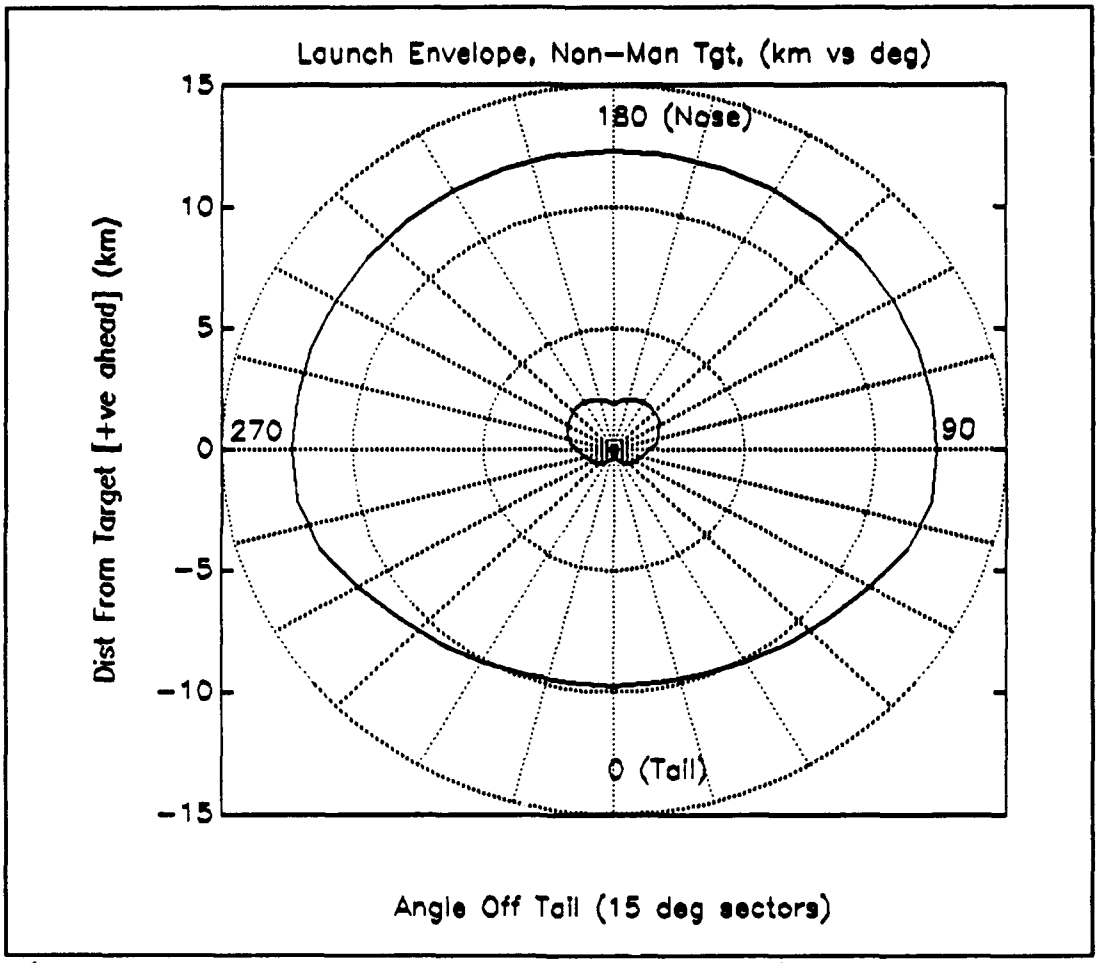

Figure 2 Launch Envelope vs Non-maneuvering Target

The launch envelope defines the extent of the launch acceptable region around the target aircraft for specific shooter and target altitudes, velocities, and target maneuvers. The envelope has both an outer and inner limit. Any

missile launch between the outer and inner limits is predicted to result in a miss distance at intercept that will result in a target kill due t- the proximity fuzed detonation of the high explosive warhead on the missile. Thus, a missile's launch boundaries around the target reflect the missile's kinematic capabilities and the warhead's lethality.

The outer boundary reflects the maximum aerodynamic or kinematic launch range at which the missile is capable of guiding to within the lethal miss-distance of the target; however, for an IR guided SRAAM the forward half of the envelope is most often a seeker limit and not the kinematic limit of the missile versus the target. This is because the target's IR signature is much weaker in the forward hemisphere and the seeker may not have a sufficient signal-to-noise ratio (SNR) for lock-on or guidance. The difference between the seeker limit and kinematic limit for an IR SRAAM is shown in Figure 3. The inner boundary surrounding the target is the minimum range limit. Depending on the aspect, this may be the result of the missile's turning ability, fuze arming time, the seeker's gimbal limits or line-of-sight (LOS) tracking rate, or even the missile guidance (autopilot) time constant.

The launch envelope against a maneuvering target is similar to the non-maneuvering case and illustrates the same conditions. Typical convention for launch envelopes is that the target aircraft begins a level turn as the missile is launched and continues this turn throughout the missile TOF.

The envelope in this case is somewhat asymmetrical, and becomes more so as the load factor of the target turn maneuver

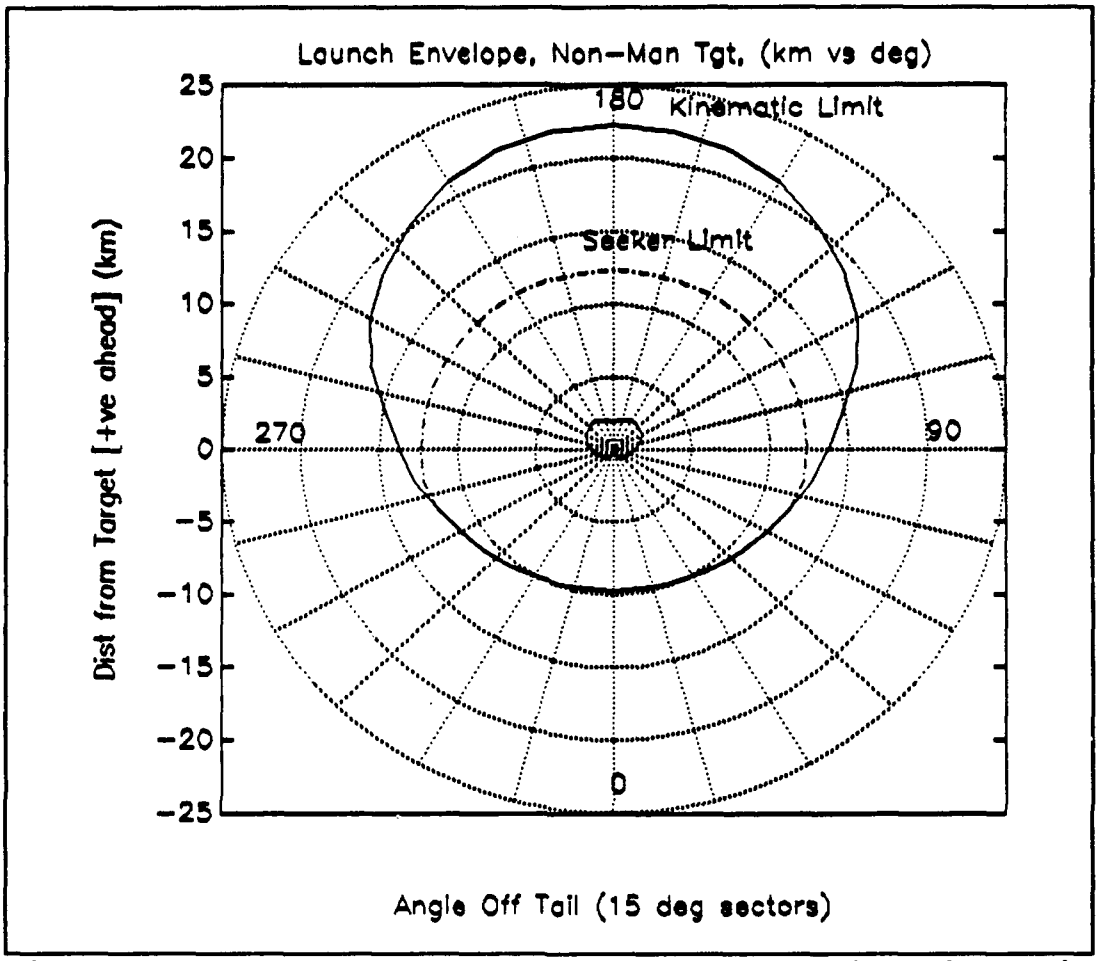

Figure 3 Launch Envelope for an IR SRAAM showing kinematic and seeker limit in the forward Hemisphere.

is increased. The envelope begins to shrink in some regions, because the missile must deplete more energy to hit the target. Thus, launches that had just enough energy to intercept a non-maneuvering target at a particular launch distance may not have sufficient energy to successfully intercept a maneuvering target. Figure 4 is an example of a launch envelope for a typical SRAAM versus a maneuvering

target (in this case, turning to the left). Typical nomenclature defines the target's "hot side" and "cold side"

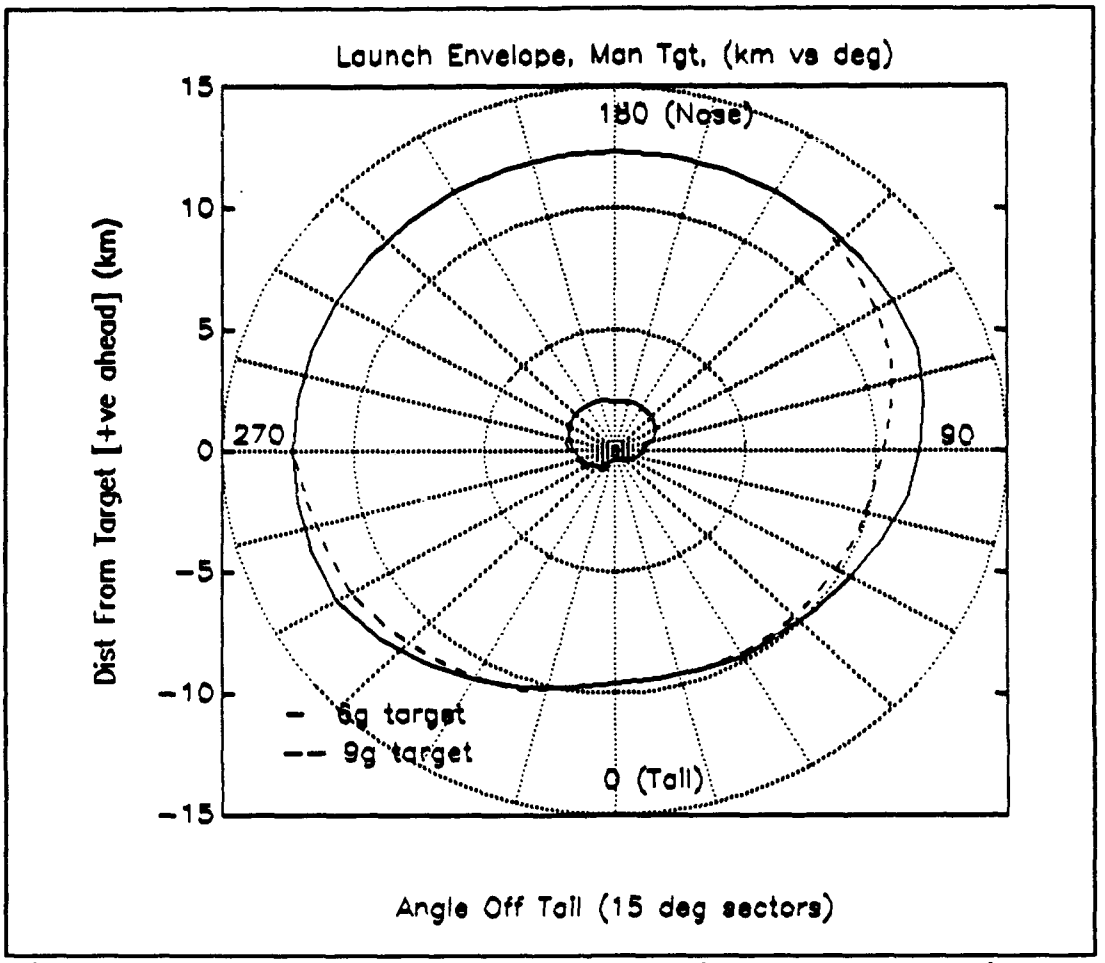

Figure 4 Launch Envelope vs Maneuvering Target Turning to the Left

as turning toward the missile or away from it, respectively. These terms reflect initial conditions because they are referenced to the target which is turning throughout the missile TOF.

The *TRAP* program structure includes a missile launch envelope generator. Flyouts can be generated over a user

specified grid, or a boundary search method is available to find the inner and outer launch boundaries which define an acceptable launch envelope against both maneuvering and non-maneuvering targets. The grid method sets up an intercept trajectory from every point in a pre-specified grid. The boundary search method attempts to define the boundary between acceptable and unacceptable engagements using miss distance as the criteria. The launch zones can be calculated for either the horizontal or vertical plane. For launch zones in the horizontal plane, the aspect is the azimuth angle with respect to the target (angle-off-tail). In the vertical plane, 'aspect' represents the missile launch altitude.

III. SIMULATED MISSILE

A. GENERAL

The purpose of this study is to determine if DIT technology will increase the lethality of a generic SRAAM. This will be accomplished by simulating the SRAAM in various engagements with TRAP. The kinematic performance of the generic SRAAM should be somewhat indicative of currently fielded SRAAM capabilities. The performance capabilities of the AIM-9L/M Sidewinder were studied and an unclassified generic model was built for use in the TRAP simulation. A complete listing of the TRAP missile data files used are contained in Appendix A.

B. SEEKER

The seeker modelled was a "perfect-filter" IR type. If SKRFLG = PERFECT-FILT (in the SSEEK.DAT data file - see Appendix A) the seeker axis will always point to the target subject to gimbal lag biases and limits. However, the LOS rate commands are generated from "filtering" the true LOS rate after it has been resolved into horizontal and vertical components in the missile body axes. The effect is to produce a lag in the generation of missile guidance commands. Important variables from the SSEEK.DAT file which characterize

the seeker are listed below (and other variables may be checked in Appendix A):

- TYPSEK = IR (seeker type);
- SKRFLG = PERFECT-FILT (seeker simulation type);
- SEKGAD = 60 deg (seeker gimbal limit);
- SEKGRD = 20 deg/s (gimbal angular rate limit);
- ZFVLMD = 6 deg (vertical half angle field-of-view);
- YFVLMD = 6 deg (horizontal half angle field-of-view);
- SNRREQ = 1.5 (signal-to-noise ratio required);
- NEI = 0.000000011 W/sr (Noise Equivalent Intensity);
- LAMLOW = 3.9 μ (lower limit on seeker wavelength); and
- LAMUP = 4.5 μ (upper limit on seeker wavelength).

The above variables approximate a modern reticle tracking IR seeker.

C. GUIDANCE

The missile guidance scheme is modelled using the inputs given in the data file SGUID.DAT (see Appendix A). The generic SRAAM uses proportional navigation (pronav) guidance with a guidance constant of 4.0. Important variables from the SSEEK.DAT file which describes the guidance characteristics are listed below (and other variables may be checked in Appendix A):

- TYPGDP = PRONAV (pitch guidance type);
- TYPGDY = PRONAV (yaw guidance type);
- TINGD = 0.4 sec (time to initiate guidance after launch);

- MMNTIM = 1.5 sec (min safe arming time);
- MMXTIM = 60 sec (max guided flight time);
- LOWMSV = 100 m/s (lowest allowable missile velocity);
- MDPERM = 5.0 m (warhead lethal radius);
- NVCNST = 4.0 (navigation constant for pronav);
- GPNDYN = PURE-GAIN (guidance filter transfer function); and
- GPNK = 1.0 (guidance filter gain).

D. CONTROL SYSTEM

For the point-mass model of the generic SRAAM, no missile autopilot or control system is modelled. For 3-,5-, and 6-DOF models, all guidance commands generated by the guidance system are processed by an autopilot controller in the routine CNTRLP and CNTRLY for the pitch and yaw autopilots, respectively. The modified guidance commands due to applying the variable gains from the SGTBLE.DAT table 'CONTROLLER GAIN VS DYNPRS(N/M2)' (see Appendix A) are the lateral accelerations that will be demanded from the missile in the aerodynamics routines. The important variables which describe the missile autopilot for a point-mass simulation are listed below (SAUTOP.DAT is listed in Appendix A):

- MXHGCG = 30 g (max g's in plane of horizontal fins);
- MXVGCG = 30 g (max g's in plane of vertical fins);
- ACDY = PURE-GAIN (transfer function for controller); and
- ACK =1.0 (controller gain).

E. AERODYNAMICS

1. General

For point-mass simulations, no control deflections are modelled (see Chapter IV Section D above). The acceleration demands generated by the missile autopilot controller are used in the routine AEROPM and converted to force coefficients and the corresponding angles-of-attack (α) and -sideslip (β) required to produce the maneuver. The actual missile angles-of-attack and -sideslip are constrained by the maximum rates-of-change for these angles. It is also assumed that the change in the aerodynamic characteristics of the generic SRAAM are negligible between initial and burnout mass.

2. Pitch and Yaw Plane Calculations

Specifically, the normal-force coefficients that will produce the required accelerations in each of the fin planes are calculated, and the corresponding trimmed angle-of-attack is subsequently extracted from tabular data which is input in the AEROTBLE.DAT file.

3. Axial Force Calculations

For point-mass models, no control system is modelled. Therefore, to calculate a realistic axial force coefficient (C_A) the program calculates simulated control surface deflections from tabular data input in the AEROTBLE.DAT file. From trim control deflection values, the corresponding incremental axial force coefficient due to control deflection

($C_{A\delta}$) is also extracted from tabular data. Additionally, C_A for zero control deflection is extracted from AEROTBLE.DAT. Thus, the total C_A is calculated by summing the incremental $C_{A\delta}$'s due to the simulated control surface deflections with the zero deflection C_A. The lateral and axial forces are then calculated for use in the missile equations of motion in the routine PMISEQ.

4. Aerodynamic Data

Two data files are used to describe the missile aerodynamic characteristics. The SAERO.DAT file describes the missile single-valued aerodynamic parameters, and AEROTBLE.DAT is a collection of data tables (both SAERO.DAT and AEROTBLE.DAT are listed in Appendix A). Important variables from the SAERO.DAT file which characterize the generic SRAAM are listed below:

- TYPAERP = NON-LINEAR (pitch aerodynamics simulation type);
- TYPAERY = NON-LINEAR (yaw aerodynamics simulation type);
- TIMCNT = 0.0 sec (time after launch for control unlock);
- AREA = 0.0127 m^2 (reference area for aerodynamics);
- LONREF = 0.127 m (longitudinal aero reference length, diameter);
- LATREF 0.127 m (lateral aero reference length, diameter);
- ADOTMX = 3.0 rad/s (max rate of change of α); and
- BDOTMX = 3.0 rad/s (max rate of change of β).

The tabular data file AEROTBLE.DAT contained the following tables for the point-mass simulation of the generic SRAAM:

- CA VS MACH & ALTITUDE(M) (PWR OFF);
- CA VS MACH & ALTITUDE(M) (PWR ON);
- CNTRIM VS ALPHATRIM(DEG) & MACH;
- CADELT VS ALPHA(DEG) & DELTA(DEG) & MACH;
- CNL VS ALPHA(DEG) & DELTA(DEG) & MACH;
- CMREF VS ALPHA(DEG) & DELTA(DEG) & MACH;
- CNTRIMMAX VS MACH;
- ALPHAMAX VS MACH; and
- DELTRM VS ALPHATRIM(DEG) & MACH.

Figure 5 below is a graph of C_A vs Mach for both the power on and power off cases for the generic SRAAM of values extracted from the 'CA VS MACH & ALTITUDE' tables. Note the higher values for the power off case showing 'boattail drag'.

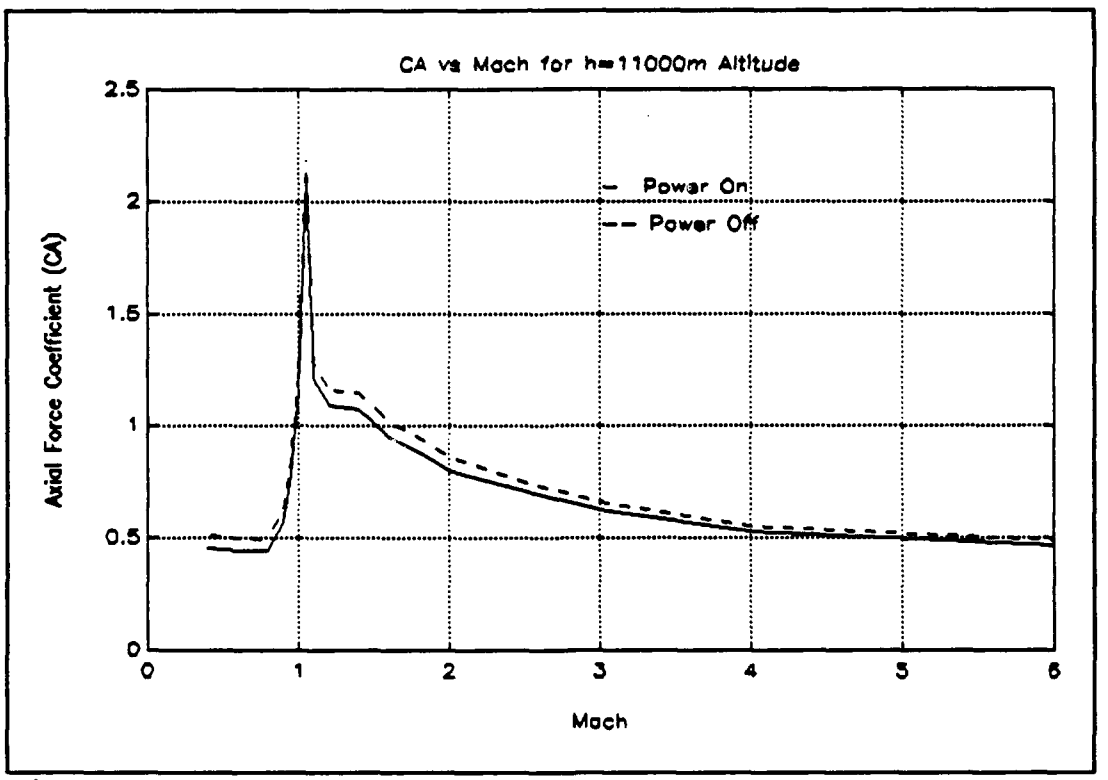

Figure 5 CA vs Mach for Generic SRAAM, h=11000 m

Figure 6 is a graph of the trim normal force coefficient ($C_{N_{trim}}$) vs Mach as a function of α_{trim}. The graph shows that values for $C_{N_{trim}}$ increase as α_{trim} increases. Values for this graph were extracted from the 'CNTRIM VS ALPHATRIM(deg) & MACH' table.

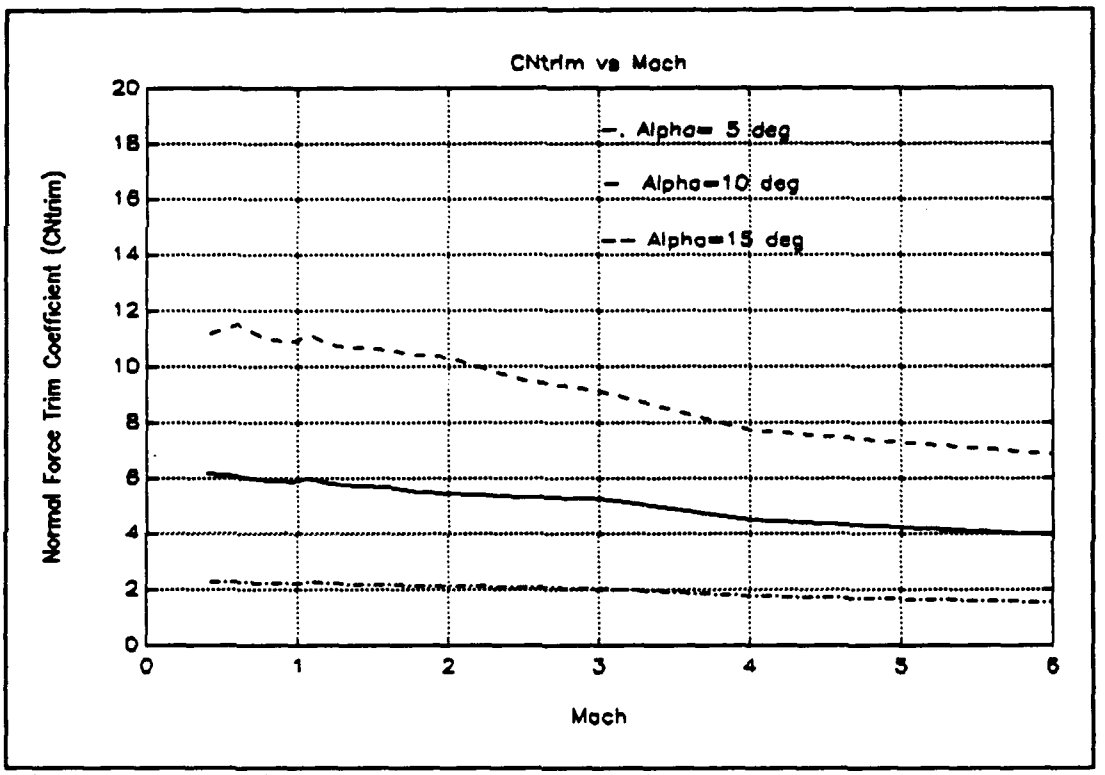

Figure 6 CNtrim vs Mach for generic SRAAM

Another important set of data which is contained in AEROTBLE.DAT is the 'CNTRIMMAX VS MACH' table which is the variation of maximum trim normal-force coefficient ($C_{N_{trimmax}}$) with Mach number. This data is used to calculate the aerodynamic loading ('g') available to the missile normal to

its flight-path in the 'pitch' plane of the fins. Figure 7 is a graph of $C_{Ntrimmax}$ vs Mach for the generic SRAAM and shows a peak normal force coefficient near Mach=1.1.

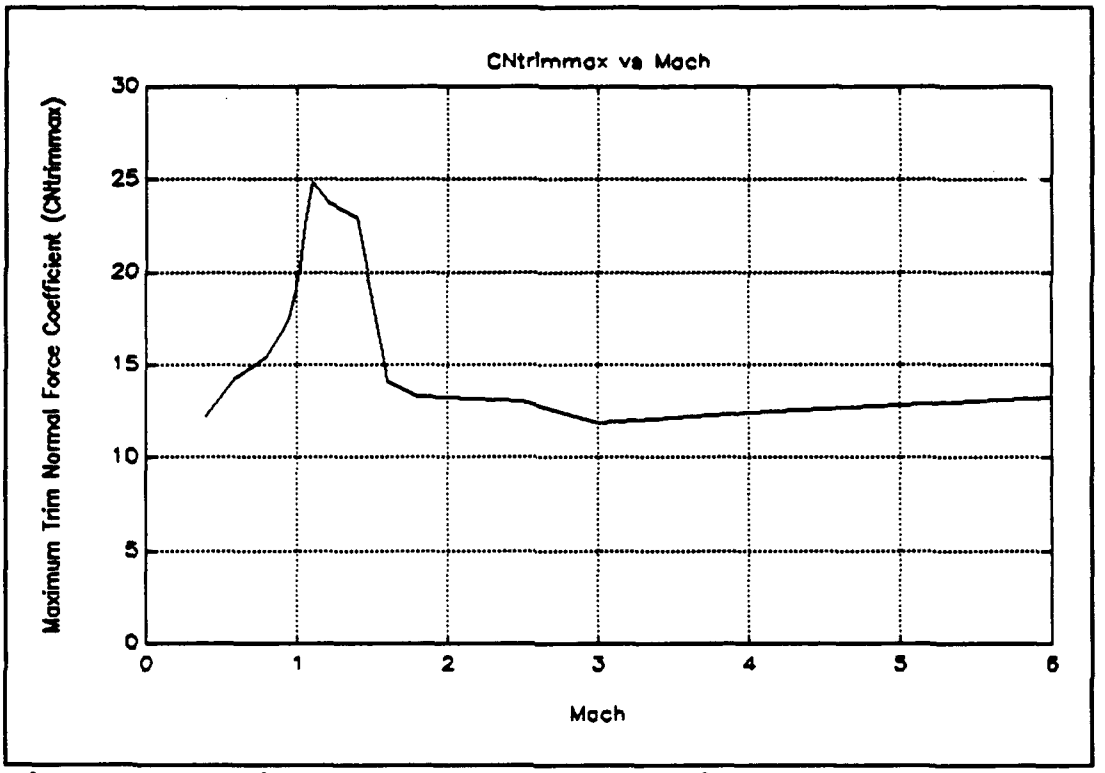

Figure 7 CNtrimmax vs Mach for generic SRAAM

Another set of data which complements 'CNTRIMMAX VS MACH' in AEROTBLE.DAT is the table 'ALPHAMAX(DEG) VS MACH' which is the variation of maximum trim α with Mach number. The data in this table is consistent with $C_{Ntrimmax}$ data. Like the data above in 'CNTRIMMAX VS MACH', the data from this table is also used to calculate the aerodynamic loading ('g') available to the missile normal to the flight path. As above, the data from

this table is in the plane of the fins. Figure 8 is a graph of data extracted from the table 'ALPHAMAX(DEG) VS MACH' for the generic SRAAM being modelled. The shape is similar to Figure 7 above, with a peak α near M=1.1, a decrease at M=3, and a gradual increase above M=3.

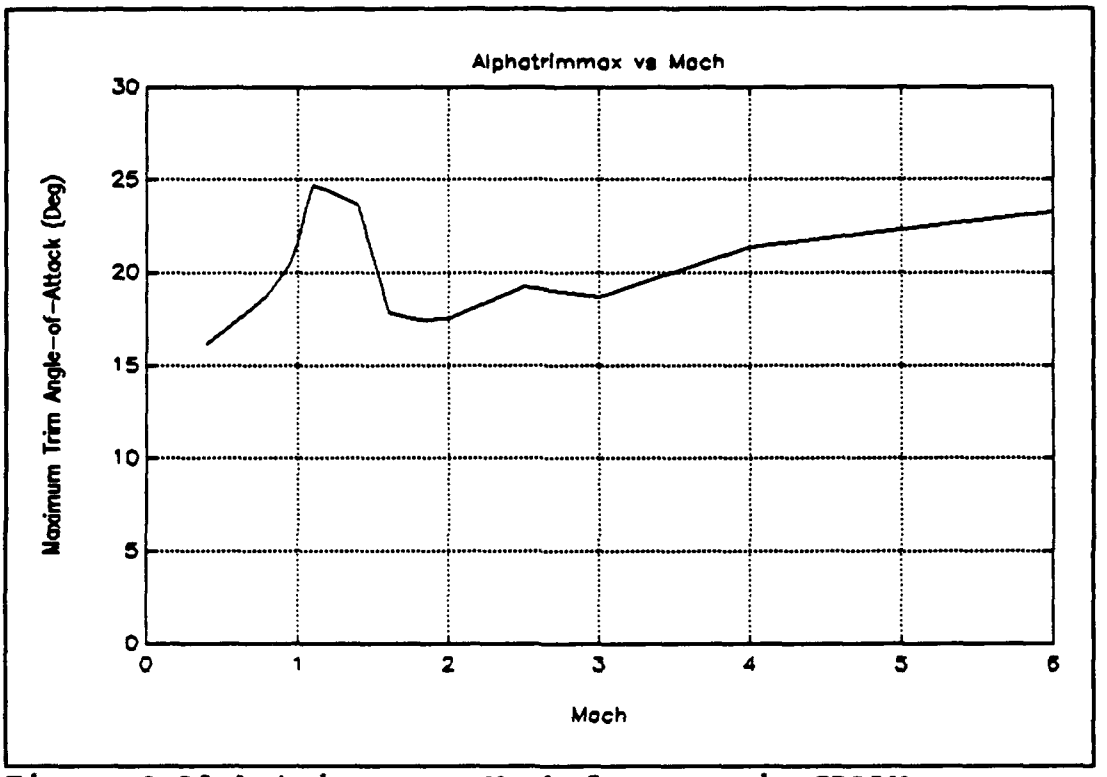

Figure 8 Alphatrimmax vs Mach for generic SRAAM

F. MASS PROPERTIES

Two data files are used in modelling the mass properties of the simulated missile. SMASS.DAT is a listing of missile mass properties, and SPROP.DAT is a listing of propulsion mass properties. The current missile mass is calculated from the missile mass one time step ago and the amount of propellant

burned. Specifically, total amount of propellant burned is calculated as the difference between the initial missile mass INMSMS (in the SMASS.DAT data file) and current missile mass. Similarly, the current missile center-of-gravity (C of G) is calculated from the initial missile mass INMSMS, the initial C of G position INITCG (both from SMASS.DAT), and the amount of propellant burned taking into account the C of G of the propellant CGPROP (also from SMASS.DAT), which is constant, denoting a radial burn grain (see below in Chapter IV Section G). Moments of inertia, however, are not calculated in the point-mass simulation. Important mass property variables for the generic SRAAM are listed below (SMASS.DAT is also listed in Appendix A):

- SYMMET = TRUE (missile symmetry about XY plane);
- INMSMS = 85.28 kg (initial missile mass);
- INITCG = 1.57 m (initial missile C of G);
- BOMSMS = 57.61 kg (burn-out missile mass);
- BOCG = 1.39 m (burn-out missile C of G); and
- CGPROP = 1.94 m (C of G of missile propellant);

G. PROPULSION

Two data files are used in modelling the point-mass generic SRAAM. SPROP.DAT describes the missile single-valued propulsion parameters. PPTBLE.DAT is a data file which contains the table 'VACUUM THRUST(N) VS TIME(SEC)' which lists the non-constant thrust values (in Newtons) vs time profile

for the radial burn rocket motor. Longer range missiles often use end-burn (or 'cigarette-burn') solid propellant grains for long duration and low thrust. However, most, if not all short-range contemporary missiles use radial burn solid propellant grains because of the benefit of large burn areas and therefore high thrust values for short periods of time.

The vacuum thrust returned from the table is reduced by the product of the nozzle exit area and the ambient pressure contained in the atmospheric properties table. The rate of propellant burn is calculated from the vacuum thrust and the input specific impulse VACISP (in SPROP.DAT). Both SPROP.DAT and PPTBLE.DAT are contained in Appendix A. Important values from SPROP.DAT are listed below:

- TYPTHR = VAC-VS-T (motor type, vacuum-thrust vs time);
- EXAREA = 0.0104 m^2 (motor exit area);
- VACISP = 2450.0 Ns/kg (vacuum specific impulse);
- TIGN1 = 0.0 s (stage 1 ignition time after launch); and
- TB1 =6.1 s (stage 1 burn time).

The vacuum thrust vs time profile for the generic SRAAM detailed in the 'VACUUM THRUST(N) VS TIME(SEC)' table is shown in Figure 9. This thrust profile is typical of many contemporary SRAAM's. Since solid propellant rocket motors cannot be throttled as can liquid fuel types, an innovative fixed burn-time profile must be designed. With only one radial burning grain, elements of 'boost' and 'sustain' must be

incorporated into the burn to best utilize the propellant energy. Note the beneficial thrust spike at the beginning of the burn indicating the ignition transient. This peak quickly boosts the missile's velocity. This is followed by a 'neutral' burn for the majority of the remaining burn time, and a tail-off indicating the burning of the sliver for a star shape grain pattern. The development of the DIT rocket motor is an attempt to improve on the limitations of the single grain burn (see Chapter IV).

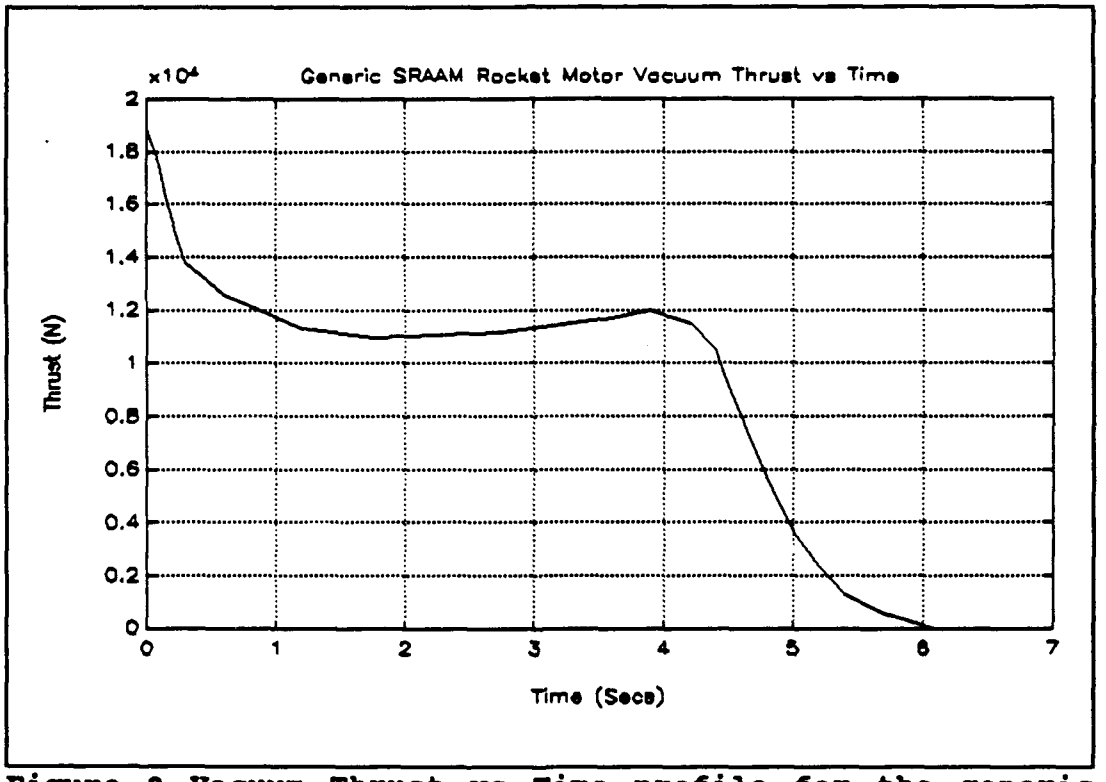

Figure 9 Vacuum Thrust vs Time profile for the generic SRAAM unmodified rocket motor

IV. DIT ROCKET MOTORS

A. GENERAL

DREV has developed a new pulse motor concept designated dual-interrupted-thrust (DIT) [Ref. 2:pp 308-312]. Their concept demonstration motor is shown in Figure 10. The motor consists of two tandem propellant grains which are separated by an interstage bulkhead. The bulkhead has a central opening which is sealed by a frangible cover during combustion of the first stage grain. This cover is designed to withstand the pressure applied from the first-stage grain, but to fragment

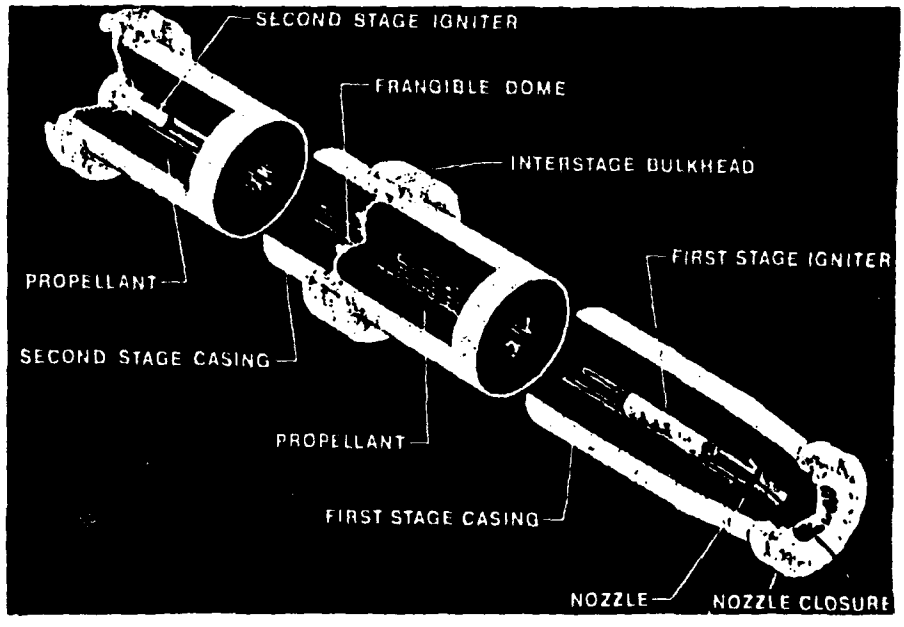

Figure 10 DIT concept demonstration motor

when pressure is applied from the second stage. This allows for the port area to be substantially greater than the nozzle throat area. In motor firings of the second stage, no significant energy loss was documented by Carrier et al [Ref. 2:p. 311] due to the empty first stage; the measured standardized specific impulse (I°_{sp}) was only 2-3% lower than theoretical for a single stage motor. Thus the preliminary testing carried out at DREV shows that a flyable DIT motor is plausible with today's technology.

B. DIT MOTORS FOR EVALUATION

1. General Motor Parameters

The purpose of this study is not to design a workable DIT rocket motor. Rather, it is the analysis of missile kinematic performance and lethality given pulse motor thrust profiles. However, a baseline rocket motor in terms of size, weight, and Maximum Expected Operating Pressure (MEOP) had to be developed which would provide reasonable thrust and pressure values for use in this study. The motors were chosen to have the following characteristics:

- propellant composed of ammonium perchlorate (AP) oxidizer with hydroxyl terminated polybutadiene (HTPB) binder in the ratio of 85/15;
- radial burn star grains (all are 6 point stars except stage 2 of Configurations 3 and 4 which are 8 point stars) giving a volumetric loading of 0.85;
- initial propellant mass of 27.22 kg (60 lb);

- MEOP of 15.2 MPa for the DIT motors with a with a reproducibility tolerance of 7%;
- propellant temperature range from -65°F to 150°F, and a nominal temperature of 70°F; and
- total motor volume available of 0.01919 m^3 (1171.6 in^3).

Using the above information and the techniques from the NPS course AE 4452 Tactical Missile Propulsion and accompanying notes [Ref.3], as well as a NASA paper on grain design [Ref.4:pp. 32-35], input data was calculated for two propulsion computer codes. *Micropep* [Ref. 5] was used in conjunction with the *Rocket* motor performance computer code [Ref. 6] for calculation of the mean thrust and burn times of the various rocket motors, given a realistic MEOP. The input and output data for *Micropep* is given in Appendix B and the input data for *Rocket* for all the motor configurations developed is given in Appendix C. Among the outputs *Rocket* generates are tables of time, thrust, chamber pressure, and total impulse. Selected time values and the associated thrust value from these output tables were used in the table 'VACUUM THRUST(N) VS TIME(SEC)' in the PPTBLE.DAT data file for *TRAP*. Copies of all PPTBLE.DAT data files used in this study are contained in Appendix A.

2. Definition of Motor Parameters

The following motor parameters define the DIT Configurations developed:

- propellant mass fraction for the first stage (mf_1);

- propellant mass fraction of the second stage (mf_2);
- mean thrust value for the first stage ($\bar{F}_1$);
- first stage burn time (TB1);
- time delay between pulses (δ);
- mean thrust value for the second stage ($\bar{F}_2$); and
- second stage burn time (TB2).

Figure 11 is a typical DIT thrust-time profile illustrating the important defining variables.

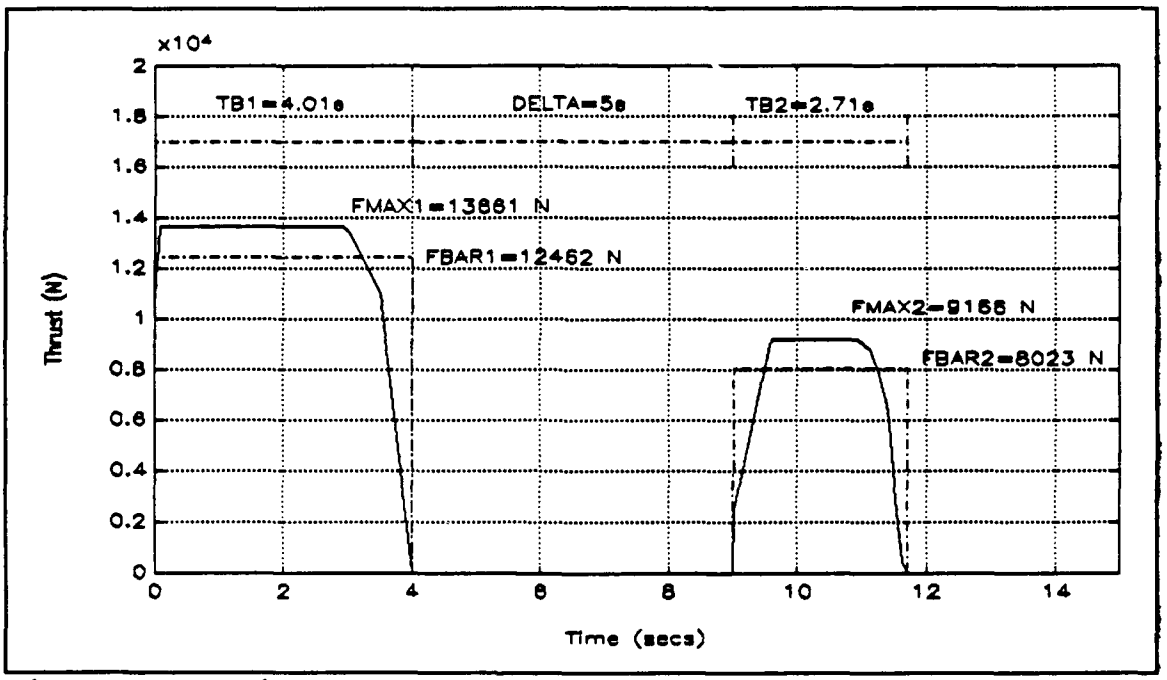

Figure 11 Typical DIT Thrust-Time Profile

Four motor configurations were developed for evaluation in this study, based on division of mass fraction. Each configuration was subdivided into a further four variants, based on δ. Table 2 lists all the configurations and their

variants to be tested in this study, and their major characteristics.

TABLE 2: DIT ROCKET MOTOR VARIANTS

Configuration	mf_1	mf_2	$\bar{F}_1$(N)	TB1(s)	δ(s)	$\bar{F}_2$(N)	TB2(s)
Generic	1.00	-	11121	6.0	-	-	-
1A	0.50	0.50	12455	2.88	2.0	12043	2.98
1B					4.0		
1C					5.0		
1D					6.0		
2A	0.60	0.40	12402	3.47	2.0	10835	2.64
2B					4.0		
2C					5.0		
2D					6.0		
3A	0.67	0.33	12531	3.83	2.0	9138	2.63
3B					4.0		
3C					5.0		
3D					6.0		
4A	0.70	0.30	12462	4.01	2.0	8023	2.71
4B					4.0		
4C					5.0		
4D					6.0		

To simulate the DIT motors in *TRAP*, the data file SPROP.DAT also had to be changed in addition to PPTBLE.DAT for each motor. The variables which had to be changed were:

- VACISP (vacuum specific impulse) which increased with the DIT motors to 2626.4 Ns/kg;
- TB1 (burn time 1st stage - from Table 2);
- TIGN2 (ignition time, 2nd stage = TB1 + δ - from Table 2); and
- TB2 (burn time 2nd stage - from Table 2).

V. THE ENGAGEMENT SCENARIOS

A. SCENARIO SELECTION

The CF has tasked BAL to complete a study to determine the kinematic performance advantages of DIT technology for both the short range AIM-9M Sidewinder and the medium range AIM-7M Sparrow air-to-air missiles currently in the CF inventory. BAL, in talks with CF aircrews, developed a series of five general engagement scenarios which could be used to determine the kinematic capabilities of the missiles in question. The five threat engagement scenarios are:

- a head-on shot against a non-maneuvering target;
- a head-on shot against a maneuvering target;
- a shoot-up against a maneuvering target;
- a minimum range beam shot against a non-maneuvering target; and
- a shot against a maneuvering target approaching 45 degrees off the nose.

In order to accomplish this study, BAL had to develop the scenarios on which to base their study. Using these five baseline scenarios, BAL has developed a kinematic Performance Index (PI) in their technical proposal to the CF [Ref. 7].

Using the above general scenarios selected by CF aircrews, detailed engagement scenarios have been developed by the author for this study. Note that the five detailed scenarios

represent discrete points in different missile launch envelopes. Together they are a representation of the kinematic capabilities of the missile deemed important by CF aircrews.

B. DETAILED ENGAGEMENT SCENARIOS

1. Head-on Shot Against a Non-Maneuvering Target

This scenario is designed to determine the critical outer part of the envelope against a target approaching from ahead. This type of engagement is often described as the F-Pole case. F-Pole is the term which denotes the separation distance between the launch aircraft and target aircraft with no maneuvering at the time of missile impact. A typical F-Pole engagement is shown in Figure 12. Here, the shooter, at 0 km downrange, fires the missile at the target, at 14 km downrange. The missile intercepts the target at 11 km downrange

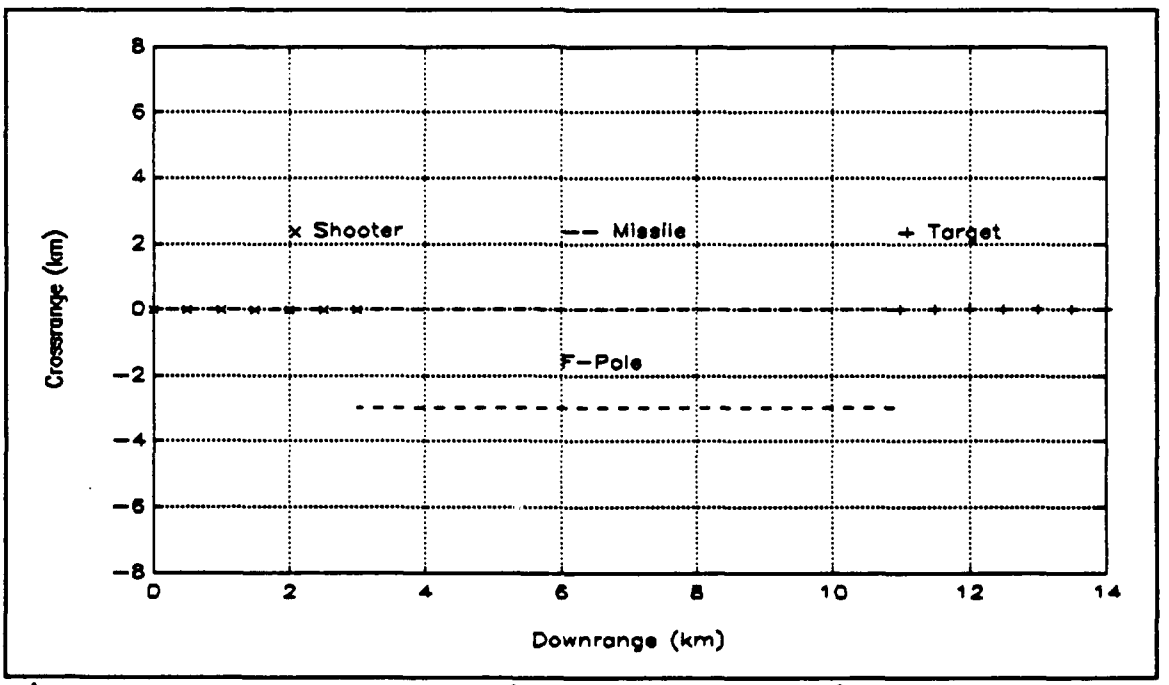

Figure 12 Head-on Shot Against Non-maneuvering Target

from the initial launch point. In the meantime, the shooter has reached 3 km downrange when the missile completes the intercept. Thus, in Figure 12 the F-Pole is 8 km. F-Pole is significant to the fighter community because it is a measure of the launch aircraft's survivability. The reason for this is as follows. If the target aircraft also launches a missile some time during the encounter before or after the friendly shooter fires, and it hits the friendly aircraft before the friendly's missile hits the target aircraft, then the target has the more lethal missile. Note that in this case, the F-Pole between the enemy shooter and friendly target would be greater than the F-Pole between the friendly shooter and enemy target had the enemy not fired. Thus, a greater F-Pole denotes a kinematically better, and thus more lethal, missile.

The *specific engagement* parameters which were chosen to test this case are as follows:

- co-altitude engagement at h=5000 m;
- Shooter velocity (V_s) = 290 m/s (M=0.9);
- Target velocity (V_t) = 290 m/s (M=0.9).

The values to be determined are maximum and minimum launch ranges (R_o and R_i respectively) for a successful intercept (i.e. an intercept within the lethal radius of the warhead) and the missile TOFs.

In general, for a forward aspect shot, the missile limitation may be either kinematic or sensor related. The

missile to be studied is sensor limited for this scenario. The result of this sensor limitation is a limitation on the maximum launch range for both the conventional missile and the missile with a DIT motor.

2. Head-on Shot Against a Maneuvering Target

This engagement is a variation of the first scenario. The target, instead of flying straight and level, will maneuver in a series of S-turns until missile impact. Because the missile's intercept profile requires continued maneuvering to ensure a hit, this scenario is specifically designed to test the energy depletion of the missile. This specific scenario should highlight the benefits of DIT technology versus a conventional boost-coast missile. An example of this scenario is shown in Figure 13.

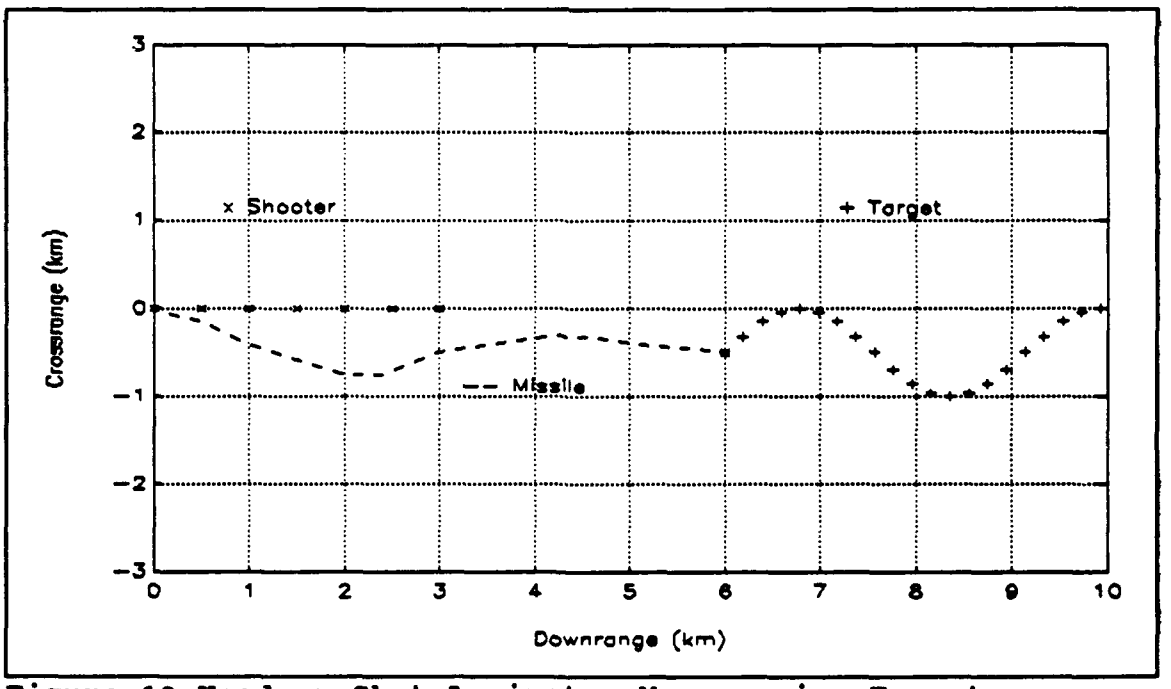

Figure 13 Head-on Shot Against a Maneuvering Target

The specific engagement parameters to test this case were chosen as follows:

- co-altitude h=5000 m;
- V_s = 230 m/s (M=0.7);
- V_t = 230 m/s (M=0.7);
- target maneuver is a constant 6g S-turn.

The values to be determined in this scenario are the maximum and minimum range for a successful intercept and missile TOFs. In this scenario, the outer boundary launch range may decrease below the seeker limit and therefore become a kinematic limit due to the loss of energy because of constant missile maneuvering.

3. Shoot-up Against a Non-Maneuvering Target

This scenario is designed to evaluate the effects of missile climb. The direct comparison is the ceiling of the missile for a successful intercept. Given the same miss distance constraint, the missile with more energy will have a higher ceiling. An example of the Shoot-up scenario is given in Figure 14.

The specific engagement parameters to test this case were chosen as follows:

- V_s = 230 m/s (M=0.7);
- $V_t \approx$ 230 m/s (M≈0.7);
- h_s = 5000 m.

The values to be determined are the missile TOF and maximum altitude of the target for a successful intercept, constrained by the seeker limit slant range R_{max} (this ensures maximum separation between the shooter and target at launch).

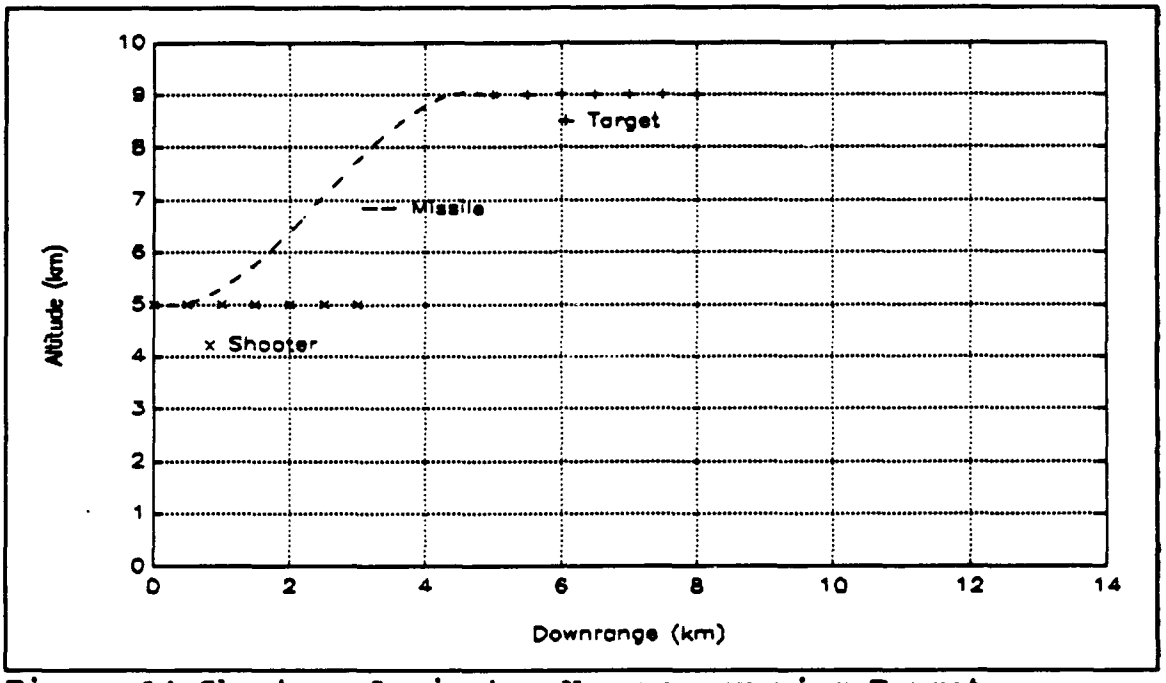

Figure 14 Shoot-up Against a Non-maneuvering Target

A diagram of the launch envelope around a target in the vertical plane illustrates that there is a maximum engagement range for an IR missile in the forward aspect which is the maximum seeker lock on range (R_{lo}) until a certain vertical separation (Δh) is achieved, after which the launch envelope becomes a kinematic limit. Scenario 3 is an attempt to find the point which is the transition between a seeker limiting shot and a kinematically limiting shot. Figure 15 is a partial diagram of the forward launch envelope around a non-

maneuvering target in the vertical plane which illustrates the above concept. Here, R_{lo}=12050 m for the missile, and the transition point is at h=5000 m. This yields a Δh of 5000 m for a target altitude of 10000 m. Better energy management and velocity-time profiles should increase this vertical separation for DIT missiles.

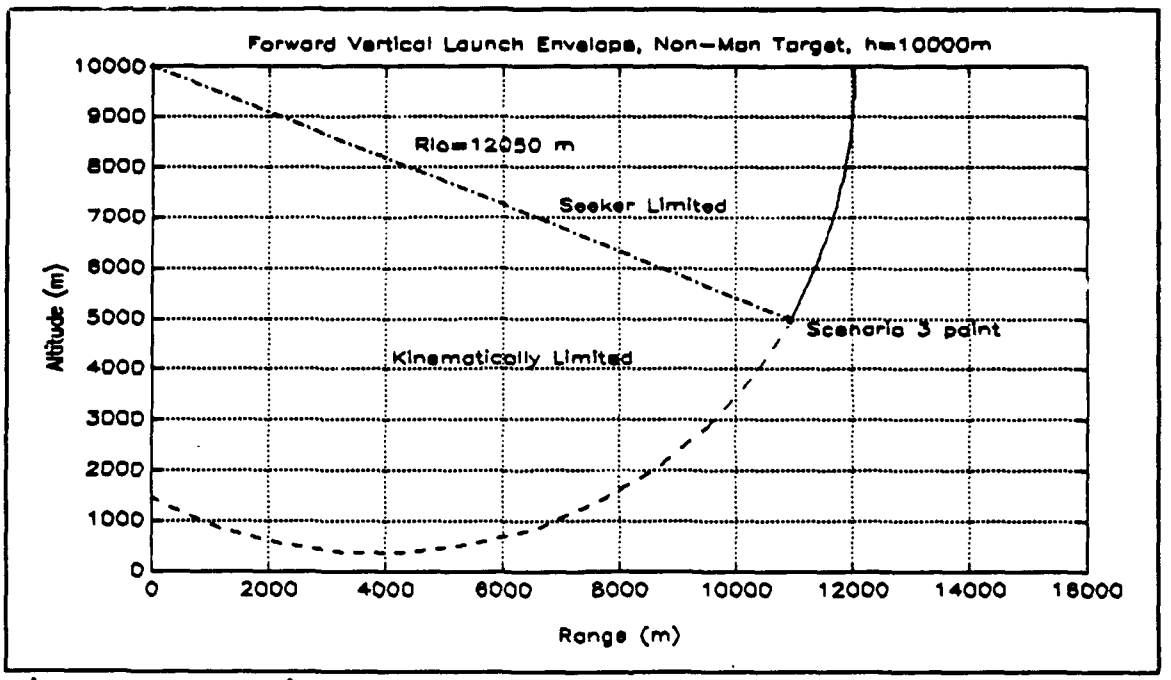

Figure 15 Vertical Launch Envelope, Forward Aspect for Non-Maneuvering Target

4. Beam Shot Against a Non-Maneuvering Target

This type of minimum range shot represents a snapshot and is an excellent test of missile maneuverability and energy depletion caused by high angle of attack and G-loadings. The maximum range shot is also a good measure of kinematic capability against a receding target. An example of this

capability against a receding target. An example of this scenario is shown in Figure 16 below.

The specific engagement parameters to test this scenario were chosen as follows:

- co-altitude engagement h=5000 m;
- V_s = 230 m/s (M=0.7);
- V_t = 230 m/s (M=0.7); and
- Angle-off-tail (AOT) = 90°.

The values to be determined will be the maximum and minimum range for a successful intercept and missile TOFs.

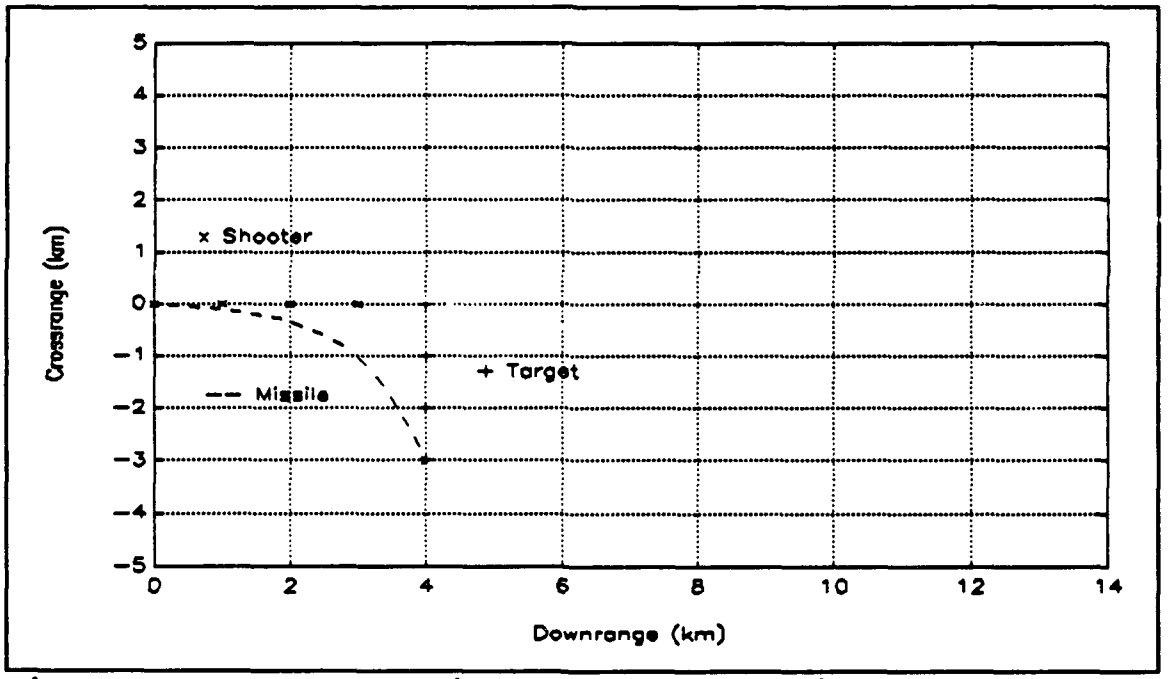

Figure 16 Beam Shot Against a Non-Maneuvering Target

5. Shot Against a Maneuvering Target 45° off Nose

This scenario also emphasizes missile maneuverability and energy depletion caused by high angle of attack and G-

loadings. An example of this scenario is shown in Figure 17.

The specific engagement parameters to test this scenario were chosen as follows:

- co-altitude engagement h=5000 m;
- V_s = 230 m/s (M=0.7);
- V_t = 230 m/s (M=0.7); and
- target maneuvers away from shooter at 7.33g.

The values to be determined in this scenario are the maximum and minimum range for a successful intercept.

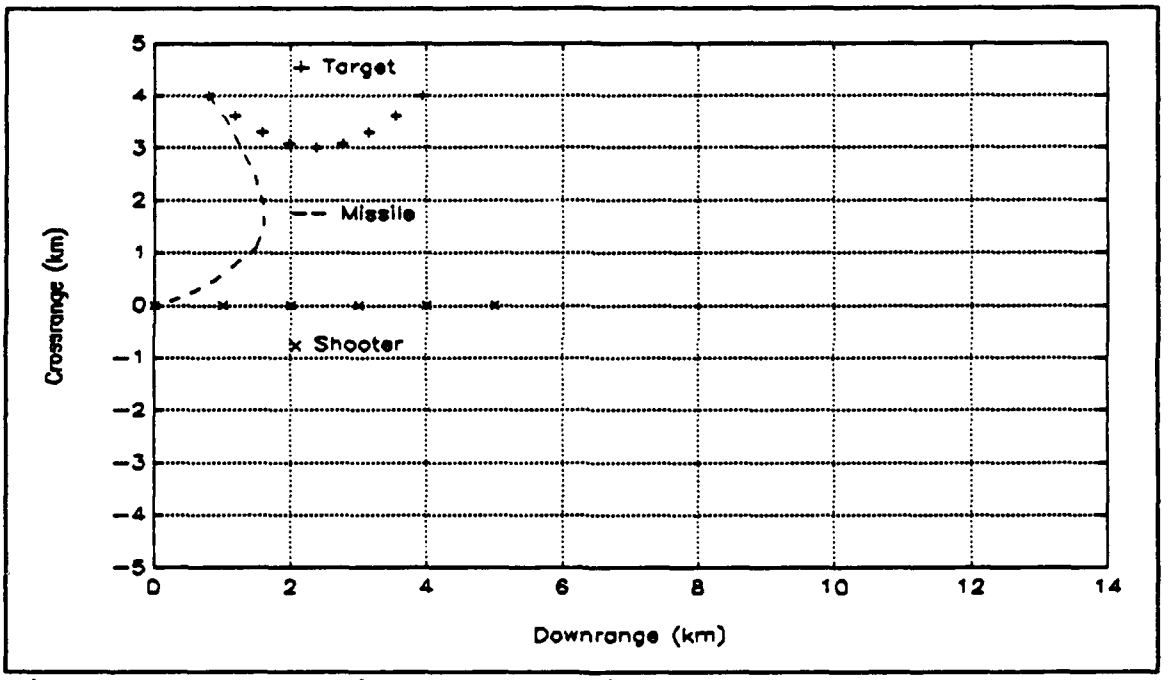

Figure 17 Shot Against Maneuvering Target 45° Off Nose

C. ADDITIONAL SCENARIOS

1. General

The above five scenarios are indicative of missile capabilities that are of concern to CF aircrews. However, this

author feels that the full benefits of DIT technology will not be measured unless more kinematically limiting scenarios are also studied. Both Scenario 1 and 2 are forward aspect shots. Scenario 1 is seeker limited and Scenario 2 may be seeker limited for an IR missile. Scenarios 4 and 5 for the BAL study are minimum range shots and do not highlight the benefits of DIT technology. Thus two more scenarios were developed for this study which were kinematically limiting to an IR missile with a DIT motor:

- Tail shot against a non-maneuvering target; and
- Tail shoot-up against a non-maneuvering target.

These additional scenarios, numbered 1A and 3A respectively, are described in detail below and are related to Scenarios 1 and 3 respectively in that they use the same launch and target aircraft altitudes and velocities.

2. Tail Shot Against a Non-Maneuvering Target

This scenario is designed to find the rear aspect launch envelope against a non-maneuvering target, which will be a kinematic limit on the missile. Figure 18 is an example of this scenario.

The specific engagement parameters to test this case were the same as Scenario 1:

- co-altitude h=5000 m;
- V_s = 290 m/s (M=0.9); and
- V_t = 290 m/s (M=0.9).

Thus, Scenario 1A represents a point on the same launch envelope as Scenario 1 due to the same launch conditions. The values to be determined are and the maximum and minimum launch range for a successful intercept and the missile TOFs.

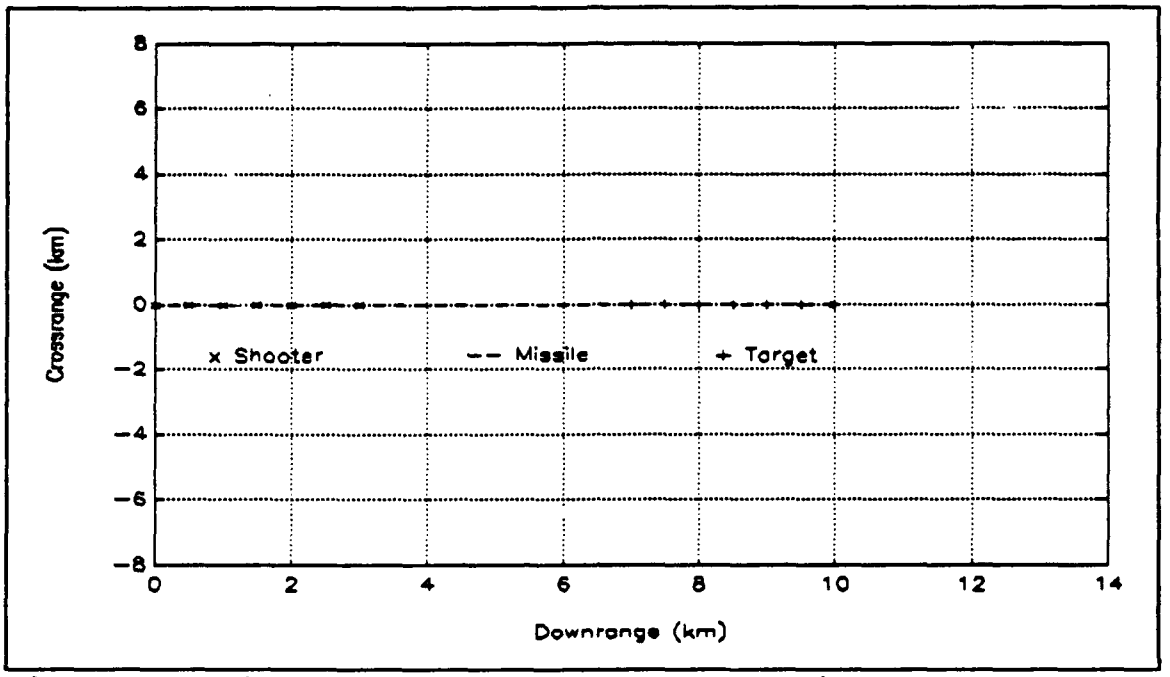

Figure 18 Tail Shot Against a Non-Maneuvering Target

3. Tail Shoot-up Against a Non-Maneuvering Target

This scenario is designed to find the rear aspect launch envelope against a non-maneuvering target at higher altitude, which will also be a kinematic limit on the missile. An example of this scenario is shown in Figure 19.

The specific engagement parameters to test this case were the same as those from Scenario 3:

- V_s = 230 m/s (M=0.7);
- V_t = 230 m/s (M=0.7);

- h_s = 5000 m; and
- h_t = value from Scenario 3.

Thus, Scenario 3A defines a point on the same launch envelope as Scenario 3. The values to be determined are missile TOF and maximum slant launch range (R_{tail}) for a successful intercept.

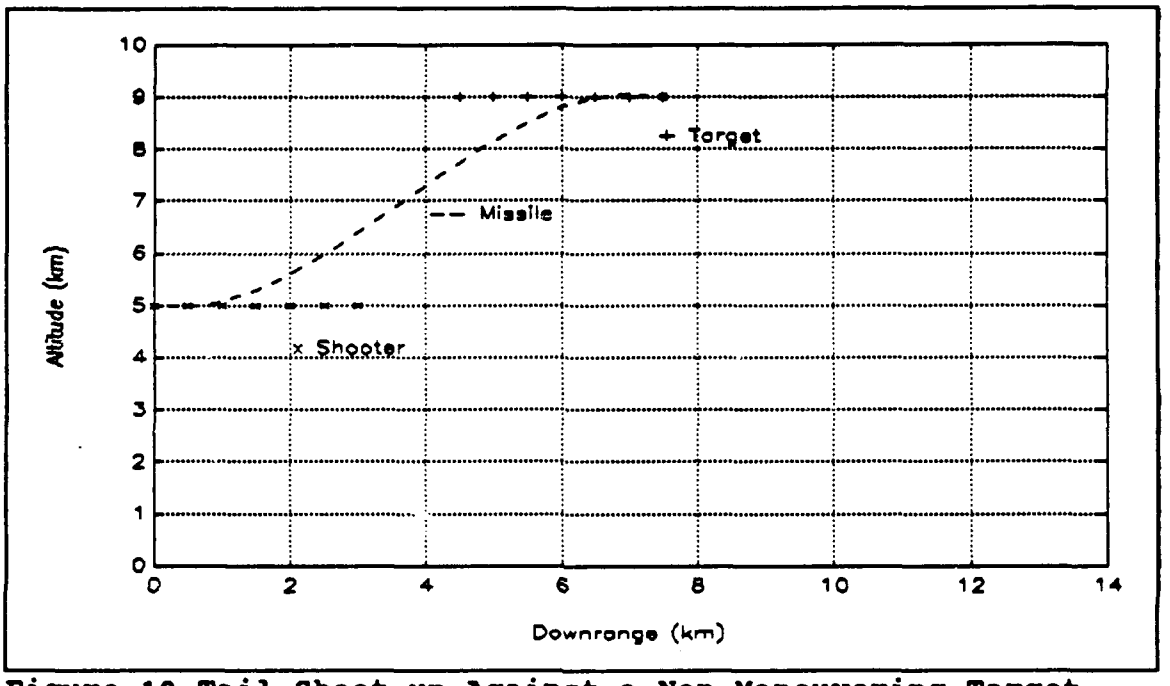

Figure 19 Tail Shoot-up Against a Non-Maneuvering Target

Table 3 is a summary of all the scenarios to be used in this study and lists the following parameters:

- scenario title;
- shooter velocity V_s and target velocity V_t;
- shooter altitude h_s;
- target altitude h_t (slant range R_{nose} for Scenario 3);
- target maneuver, if any; and
- parameters to be found.

TABLE 3A: SCENARIO SUMMARY (PARTIAL)

Scen 1	Title:	Head-on Shot against Non-Maneuvering Target
	V_o:	290 m/s (M=0.9)
	V_t:	290 m/s (M=0.9)
	h_o:	5000 m
	h_t:	5000 m
	Find:	R_o, TOF_o, R_i, TOF_i
Scen 1A	Title:	Tail Shot against Non-Maneuvering Target
	V_o:	290 m/s (M=0.9)
	V_t:	290 m/s (M=0.9)
	h_o:	5000 m
	h_t:	5000 m
	Find:	R_o, TOF_o, R_i, TOF_i
Scen 2	Title:	Head-on Shot against Maneuvering Target
	V_o:	230 m/s (M=0.7)
	V_t:	230 m/s (M=0.7)
	h_o:	5000 m
	h_t:	5000 m
	Man:	constant 6g 'S-turn'
	Find:	R_o, TOF_o, R_i, TOF_i

TABLE 3B: SCENARIO SUMMARY (CONT)

Scen 3	Title:	Shoot-up against Non-Maneuvering Target
	V_s:	230 m/s (M=0.7)
	V_t:	230 m/s (M=0.7)
	h_s:	5000 m
	R_{max}:	12050 m
	Find:	TOF, Δh (i.e. $h_t - h_s$)
Scen 3A	Title:	Tail Shoot-up against Non-Maneuvering Target
	V_s:	230 m/s (M=0.7)
	V_t:	230 m/s (M=0.7)
	h_s:	5000 m
	h_t:	from #3
	Find:	R_{tail}, TOF
Scen 4	Title:	Beam Shot against Non-Maneuvering Target
	V_s:	230 m/s (M=0.7)
	V_t:	230 m/s (M=0.7)
	h_s:	5000 m
	h_t:	5000 m
	Find:	R_o, TOF_o, R_i, TOF_i

TABLE 3C SCENARIO SUMMARY (CONT)

Scen 5	Title:	Shot against Maneuvering Target 45° Off Nose
	V_o:	230 m/s (M=0.7)
	V_t:	230 m/s (M=0.7)
	h_o:	5000 m
	h_t:	5000 m
	Man:	7.33g constant-altitude break inside shooter
	Find:	R_o, TOF_o, R_i, TOF_i

The scenarios simulated in *TRAP* are defined by the data files SCENAR.DAT (scenario description) and LARBND.DAT (launch boundary search parameters). Examples of both these data files are contained in Appendix A. The variable TGTSIG (target signature) in SCENAR.DAT was set to 40 W/sr for forward aspect engagements, and 400 W/sr for rear aspect engagements. All other variables are scenario dependent and self explanatory.

VI. PERFORMANCE ASSESSMENT AND MEASURES OF EFFECTIVENESS

A. PERFORMANCE ASSESSMENT

1. General

Criteria for determining the best thrust-time profile for the modified SRAAM selected by BAL included the maximum range and associated time-of-flight at which the missile's velocity dropped to a minimum intercept velocity (calculated for a given α and lateral acceleration requirement determined by the intercept geometry) [Ref. 7]. In this study, the criterion for a successful intercept is a miss distance within the lethal radius of the warhead as the *TRAP* launch boundary search routine uses this parameter as a constraint to find the maximum and minimum acceptable launch ranges for the missile launch envelope for a given aspect angle.

Engagement scenarios (1),(2),and (3) described in Chapter V Section B above will be considered as "primary estimators" of missile performance because they represent points on the missile launch envelope's outer boundary. Engagement scenarios (4), and (5) are the "secondary estimators" because they are points on the inner boundary. The effectiveness of the various DIT thrust-time profiles will be assessed by calculating an overall Performance Index (PI) based upon the kinematic

performance of the missile in the various engagement scenarios detailed in (1)-(5) above.

2. BAL Performance Index Calculations

BAL [Ref. 7] proposed to calculate an overall PI for each variant by comparing it to the baseline missile as described below. The average velocity V_a of the missile flyout is defined as:

$$V_a = \frac{R}{TOF} \tag{1}$$

Two PIs for each scenario (i) were selected by BAL:

$$PI(R)_i = \frac{R_i \ variant}{R_i \ baseline} \tag{2}$$

and

$$PI(V_a)_i = \frac{V_{a_i} \ variant}{V_{a_i} \ baseline} \tag{3}$$

BAL then combined the individual scenario PIs into an overall PI defined as follows:

$$PI_{overall} = \sum_{i=1}^{5} W_i \ [PI(R)_i \times PI(V_a)_i] \tag{4}$$

where W_i is a scenario weighting factor and $W_{1-3} = 1.0$ for the primary engagement scenarios and $W_{4-5} = 0.5$ for the secondary

engagement scenarios. An amendment to equations (2) and (3) were made in discussions by the author with BAL [Ref. 8]. For Scenario 3, in both these equations, altitude is to be substituted for range and thus the equation becomes a measure of vertical performance. For scenarios 4-5 which are inner boundary shots, a shorter range is more desirable hence Pi(R) has been redefined as:

$$PI(R)_i = \frac{R_i \ baseline}{R_i \ variant} \tag{5}$$

This gives an increased measure for a decreased minimum launch range. Note that the scenario PI_i defined as the product of [PI(R)] and [PI(V_a)] can be written as:

$$PI_i = \left(\frac{(R_i \ variant)^2}{(TOF_i \ variant)} \right) \times \left(\frac{(TOF_i \ baseline)}{(R_i \ baseline)^2} \right) \tag{6}$$

for scenarios 1-3 and

$$PI_i = \frac{TOF_i \ baseline}{TOF_i \ variant} \tag{7}$$

for scenarios 4-5. Thus, BAL will attempt to optimize the rocket motor configurations based on the variant to baseline R^2/TOF ratio for the primary scenarios and the baseline to variant TOF ratio for the secondary scenarios.

3. Performance Index Calculations for this Study

The maximum and minimum launch range (R) and TOF for each scenario will be calculated by *TRAP* using the launch boundary calculating routine. The results of these calculations are given in Tables 3-6 in Chapter VII. The overall PI for each DIT configuration (each giving a unique thrust-time profile) will be calculated using the formulas proposed by BAL for the purpose of comparison, except that launch range will be substituted for 'range' (i.e. missile distance travelled) as *TRAP* does not calculate this value. Additionally, the calculated $PI_{overall}$ for each missile will be normalized with respect to the baseline missile. A measure of performance for each missile variant based on the BAL PIs (MOP_{BAL}) will be calculated as follows:

$$MOP_{BAL} = \frac{PI_{overall}}{4} \qquad (8)$$

Additionally, Scenarios 1A and 3A will be added to the original five scenarios and the seven scenarios together will also be evaluated using the BAL PIs. Scenario 3A will use altitude in lieu of range for PI calculations in the same manner as Scenario 3. Scenarios 1, 1A, 3, 3A, 4, and 5 will have a weight factor W_i=0.5, and Scenario 2 will have a weight factor W_i=1.0. Thus, Scenarios 1 and 1A together will have the same contribution to the overall PI as Scenario 1 alone in the

original evaluation. Similarly, Scenarios 3 and 3A together will also have the same contribution to the overall PI as Scenario 3 alone in the original evaluation. The measure of performance for each missile variant based on these seven scenarios (MOP_{BAL7}) is defined as:

$$MOP_{BAL7} = \frac{PI_{overall}}{4} \tag{9}$$

B. LETHALITY ASSESSMENT

1. General

Ball [Ref. 9:p. 6] states that a weapon's lethality in the air defense context is its ability to encounter, engage and kill aircraft. However, the outcome of an engagement cannot be predicted with certainty, and therefore two identical engagements may not have the same outcome. Thus, weapon lethality is measured as the probability that the aircraft will be killed by the weapon, P_k, which is a number from 0 to 1. *TRAP* does not take the non-deterministic nature of an engagement into account, and thus P_k is not predicted. The missile will always fly an identical trajectory given identical initial conditions, and if the missile can guide to within lethal warhead radius of the target, the target is always considered destroyed (the probability of a kill given a warhead detonation $P_{k/d}$ at or inside of the lethal radius of the warhead is 1.0). Ball [Ref. 9:p. 8] also states that there

are many parameters which affect the lethality of a weapon. For guided missiles specifically, the following parameters influence its lethality:

- missile flight performance;
- aircraft signatures;
- missile detection and tracking abilities;
- guidance type and accuracy;
- warhead design;
- type of fuze;
- distance from the launch aircraft to target aircraft at time of launch;
- launch aircraft's and target aircraft's velocity at time of launch;
- target aircraft's velocity and flight path after launch; and
- vulnerability of the target to damage mechanisms generated by the warhead.

The DIT modification affects only the first and possibly the second parameter(s) listed above. The flight performance of the SRAAM is altered, specifically the thrust-time profile of the rocket motor and thus the kinetic energy of the missile at any given time during its flight. Additionally, the missile's IR and visual signature will be slightly altered.

2. Lethality Index Calculations

The lethality of the modified SRAAM must be compared to the lethality of the generic unmodified SRAAM. Although the lethality measure P_k cannot be directly calculated using *TRAP*,

a lethality comparison can be made given the assumptions used by TRAP. Figure 20 below is a diagram of P_k vs launch range.

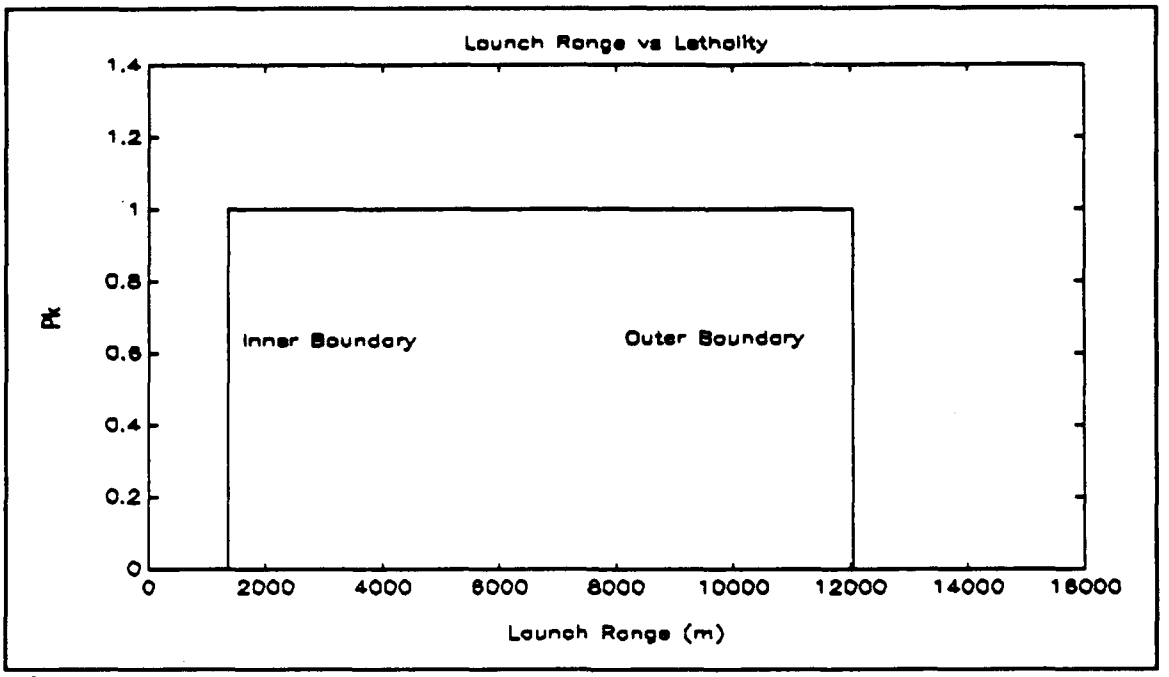

Figure 20 Pk vs Launch Range

Given any launch envelope diagram such as Figure 2, the x-axis of this diagram is a line pointing from the target radially outward at an arbitrary angle. From Figure 20 above, it can be seen that an increase in lethality will result in an increase in the distance between the outer and inner boundaries (this will cause an increase in the area under the P_k vs R_{launch} curve). Thus, a lethality comparison between missiles can be made using the ratio of the distances between the inner and outer launch boundaries. Thus, for the purposes of this study, a lethality index (LI) for the i^{th} scenario is defined as:

$$LI_i = \frac{(R_o - R_i)_{variant}}{(R_o - R_i)_{baseline}} \quad (10)$$

However, for Scenario 3 and 3A there is no inner launch boundary because only the outer limiting launch point was found. The lethality measure for Scenarios 3 and 3A will be calculated as the ratio between the altitudes multiplied by the slant launch ranges:

$$LI_{3,3A} = \frac{(\Delta h)_{variant} \times (R_{nose,tail})_{variant}}{(\Delta h)_{baseline} \times (R_{nose,tail})_{baseline}} \quad (11)$$

where R_{nose} is the slant launch range for Scenario 3 and R_{tail} is the slant launch range for Scenario 3A. Equation (11) is thus a measure of both percentage improvement in slant launch range and percentage improvement in altitude for the variant compared to the baseline missile. Each LI_i will in turn be multiplied by the scenario weighting factor and summed to produce an overall LI. W_i = 0.5 for Scenarios 1, 1A, 3, 3A, 4, and 5, and w_i = 1.0 for Scenario 2, as for the PI calculations. Finally , a total measure of lethality (MOL) is defined as follows:

$$MOL = \frac{LI_{overall}}{4} \quad (12)$$

Thus, the MOL is a measure of the percentage increase in lethality for the variants over the baseline missile based upon the selected scenarios and weighting factors.

VII. RESULTS AND ANALYSIS

A. GENERAL

The data desired for kinematic and lethality analysis are presented in Tables 4-7. The first data column in all cases contains values for the generic baseline missile. The configuration numbers which label the remaining columns refer to specific burn profiles defined previously in Table 2 in Chapter IV DIT Rocket motors. Scenarios 1, 1A, 2, 4, and 5 all contain four rows of data which are defined as:

- outer launch boundary (R_o);
- missile time of flight to outer boundary (TOF_o);
- inner launch boundary (R_i); and
- missile time of flight to inner boundary (TOF_i).

Scenarios 3 and 3A contain only three rows of data which are defined as:

- launch boundary (R_{nose} or R_{tail} for Scenario 3 or 3a respectively);
- altitude differential between shooter and target (ΔH); and
- time of flight to launch boundary (TOF).

Additionally, range headings are annotated with a (K), (SK) or (AT) to denote kinematic, seeker or arming time respectively as the limiting factor, and the boxes used for the kinematic analysis (PI calculations) are shaded.

TABLE 4: FLYOUT RESULTS CONFIGURATION 1

Configuration		Generic	1A	1B	1C	1D
Scen 1 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	11.93	11.65	12.27	12.47	12.95
Scen 1 (inner)	R_i(m) (AT)	1500	1398	1398	1398	1398
	TOF_i(s)	2.07	2.01	2.01	2.01	2.01
Scen 1A (outer)	R_o(m) (K)	7418	9760	9758	10336	9759
	TOF_o(s)	21.20	25.58	26.79	28.21	28.29
Scen 1A (inner)	R_i(m) (AT)	300	300	300	300	300
	TOF_i	2.02	2.04	2.04	2.04	2.04
Scen 2 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	14.47	13.71	14.45	14.57	15.20
Scen 2 (inner)	R_i(m) (K)	1407	1230	1230	1230	1230
	TOF_i(s)	2.33	2.08	2.08	2.08	2.08
Scen 3	R_{nose}(m) (SK)	12050	12050	12050	12050	12050
	Δh(m)	6975	7400	7250	6925	6775
	TOF(s)	22.67	21.68	22.89	21.62	20.66
Scen 3A	R_{tail}(m) (K)	10596	14567	14507	15276	14245
	Δh(m)	6975	7400	7250	6925	6775
	TOF(s)	31.08	39.62	40.66	42.26	41.16
Scen 4 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	28.11	21.12	22.03	21.64	23.06
Scen 4 (inner)	R_i(m) (K)	1391	1681	1684	1684	1684
	TOF_i(s)	4.53	5.50	5.57	5.57	5.57
Scen 5 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	21.22	19.24	19.95	19.77	20.52
Scen 5 (inner)	R_i(m) (K)	1394	1250	1250	1250	1250
	TOF_i(s)	2.33	2.12	2.12	2.12	2.12

TABLE 5: FLYOUT RESULTS CONFIGURATION 2

Configuration		Generic	2A	2B	2C	2D
Scen 1 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	11.93	11.46	11.99	12.27	12.56
Scen 1 (inner)	R_i(m) (AT)	1500	1453	1453	1453	1453
	TOF_i(s)	2.07	2.01	2.01	2.01	2.01
Scen 1A (outer)	R_o(m) (K)	7418	10031	10073	10108	10108
	TOF_o(s)	21.20	25.64	26.79	27.54	28.13
Scen 1A (inner)	R_i(m) (AT)	300	300	300	300	300
	TOF_i	2.02	2.01	2.01	2.01	2.01
Scen 2 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	14.47	13.38	13.98	14.29	14.63
Scen 2 (inner)	R_i(m) (K)	1407	1265	1265	1265	1265
	TOF_i(s)	2.33	2.12	2.12	2.12	2.12
Scen 3	R_{nose}(m) (SK)	12050	12050	12050	12050	12050
	Δh(m)	6975	8350	8200	8100	7975
	TOF(s)	22.67	20.97	21.45	21.61	21.72
Scen 3A	R_{tail}(m) (K)	10596	15569	15560	15524	15455
	Δh(m)	6975	8350	8200	8100	7975
	TOF(s)	31.08	41.71	42.73	43.20	43.54
Scen 4 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	28.11	20.47	21.20	21.59	22.01
Scen 4 (inner)	R_i(m) (K)	1391	1369	1369	1369	1369
	TOF_i(s)	4.53	4.23	4.23	4.23	4.23
Scen 5 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	21.22	18.72	19.26	19.50	19.75
Scen 5 (inner)	R_i(m) (K)	1394	1456	1456	1456	1456
	TOF_i(s)	2.33	2.38	2.38	2.38	2.38

TABLE 6: FLYOUT RESULTS CONFIGURATION 3

Configuration		Generic	3A	3B	3C	3D
Scen 1 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	11.93	11.41	11.86	12.10	12.35
Scen 1 (inner)	R_i(m) (AT)	1500	1453	1453	1453	1453
	TOF_i(s)	2.07	2.00	2.00	2.00	2.00
Scen 1A (outer)	R_o(m) (K)	7418	9992	10035	10069	10069
	TOF_o(s)	21.20	25.47	26.48	27.12	27.53
Scen 1A (inner)	R_i(m) (AT)	300	300	300	300	300
	TOF_i	2.02	2.00	2.00	2.00	2.00
Scen 2 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	14.47	13.31	13.80	14.07	14.36
Scen 2 (inner)	R_i(m) (K)	1407	1265	1265	1265	1265
	TOF_i(s)	2.33	2.12	2.12	2.12	2.12
Scen 3	R_{max}(m) (SK)	12050	12050	12050	12050	12050
	Δh(m)	6975	8750	8750	8600	8425
	TOF(s)	22.67	21.03	22.09	22.13	21.72
Scen 3A	R_{tail}(m) (K)	10596	15729	15810	15750	15656
	Δh(m)	6975	8750	8750	8600	8425
	TOF(s)	31.08	42.31	43.33	43.55	43.67
Scen 4 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	28.11	20.41	20.99	21.32	21.67
Scen 4 (inner)	R_i(m) (K)	1391	1322	1322	1322	1322
	TOF_i(s)	4.53	4.00	4.00	4.00	4.00
Scen 5 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	21.22	18.65	19.07	19.26	19.47
Scen 5 (inner)	R_i(m) (K)	1394	1456	1456	1456	1456
	TOF_i(s)	2.33	2.38	2.38	2.38	2.38

TABLE 7: FLYOUT RESULTS CONFIGURATION 4

Configuration		Generic	4A	4B	4C	4D
Scen 1 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	11.93	11.42	11.83	12.05	12.29
Scen 1 (inner)	R_i(m) (AT)	1500	1467	1467	1467	1467
	TOF_i(s)	2.07	2.02	2.02	2.02	2.02
Scen 1A (outer)	R_o(m) (K)	7418	9992	10034	10031	10031
	TOF_o(s)	21.20	25.60	26.55	26.91	27.34
Scen 1A (inner)	R_i(m) (AT)	300	300	300	300	300
	TOF_i	2.02	2.01	2.01	2.01	2.01
Scen 2 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	14.47	13.30	13.76	14.01	14.29
Scen 2 (inner)	R_i(m) (K)	1407	1265	1265	1265	1265
	TOF_i(s)	2.33	2.12	2.12	2.12	2.12
Scen 3	R_{nose}(m) (SK)	12050	12050	12050	12050	12050
	Δh(m)	6975	8775	8775	8775	8625
	TOF(s)	22.67	20.97	21.89	22.41	22.42
Scen 3A	R_{tail}(m) (K)	10596	15696	15778	15805	15744
	Δh(m)	6975	8775	8775	8775	8625
	TOF(s)	31.08	42.26	43.23	43.69	43.93
Scen 4 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	28.11	20.44	20.96	21.27	21.60
Scen 4 (inner)	R_i(m) (K)	1391	1322	1322	1322	1322
	TOF_i(s)	4.53	3.98	3.98	3.98	3.98
Scen 5 (outer)	R_o(m) (SK)	12050	12050	12050	12050	12050
	TOF_o(s)	21.22	18.66	19.03	19.21	19.40
Scen 5 (inner)	R_i(m) (K)	1394	1467	1467	1467	1467
	TOF_i(s)	2.33	2.40	2.40	2.40	2.40

B. PERFORMANCE AND LETHALITY INDICES

Tables 8-11 list, for each scenario, the Performance Index (PI) as developed by BAL, and the Lethality index (LI). These values were calculated from the formulas in Chapter VI for the above data. A measure of 1.0 denotes the generic SRAAM. Thus, a PI value greater than 1.0 denotes a superior kinematic performance than the generic missile as measured by BAL, and an LI value greater than 1.0 denotes a more lethal missile than the generic SRAAM. Similarly, a PI value less than 1.0 denotes an inferior kinematic performance to the generic SRAAM, and an LI less than 1.0 denotes a less lethal missile than the generic SRAAM.

The third from last row of each table lists the missile measure of performance (MOP) using the BAL PIs for all the scenarios except 1A and 3A. The second last row lists the MOP calculated using the PIs from all the scenarios. A MOP value of 1.0 denotes the generic SRAAM (see Chapter VI Section A).

The last row lists the measure of lethality (MOL) using the LIs of all the scenarios. A MOL value of 1.0 denotes the generic SRAAM. The MOL value listed represents the actual lethality ratio of the generic SRAAM compared to the DIT variant based on the analysis of the seven scenarios and the assumptions used by TRAP (see Chapter VI Section B).

Additionally, the rank of the variant from 1-16 is listed in parentheses beside the MOP or MOL. This allows a quick comparison of the variants and the ranking methods.

TABLE 8: PERFORMANCE AND LETHALITY MEASURES CONFIGURATION 1

Configuration		1A	1B	1C	1D
Scen 1	PI_1	1.0240	0.9723	0.9567	0.9212
	LI_1	1.0097	1.0097	1.0097	1.0097
Scen 1A	PI_{1A}	1.4347	1.3693	1.4590	1.2970
	LI_{1A}	1.3290	1.3287	1.4099	1.3289
Scen 2	PI_2	1.0547	1.0007	0.9925	0.9513
	LI_2	1.0166	1.0166	1.0166	1.0166
Scen 3	PI_3	1.1770	1.0700	1.0336	1.0353
	LI_3	1.0609	1.0394	0.9928	0.9713
Scen 3A	PI_{3A}	0.8830	0.8259	0.7249	0.7124
	LI_{3A}	1.4585	1.4231	1.4313	1.3058
Scen 4	PI_4	0.8236	0.8133	0.8133	0.8133
	LI_4	0.9728	0.9725	0.9725	0.9725
Scen 5	PI_5	1.0991	1.0991	1.0991	1.0991
	LI_5	1.0135	1.0135	1.0135	1.0135
MOP_{BAL} (rank)		1.0543 (13)	0.9998 (14)	0.9847 (15)	0.9660 (16)
MOP_{BAL7} (rank)		1.0688 (13)	1.0189 (14)	1.0089 (15)	0.9726 (16)
MOL (rank)		1.1097 (13)	1.1025 (15)	1.1079 (14)	1.0794 (16)

TABLE 9: PERFORMANCE AND LETHALITY MEASURES CONFIGURATION 2

Configuration		2A	2B	2C	2D
Scen1	PI_1	1.0410	0.9950	0.9723	0.9498
	LI_1	1.0045	1.0045	1.0045	1.0045
Scen1A	PI_{1A}	1.5119	1.4592	1.4293	1.3993
	LI_{1A}	1.3671	1.3730	1.3779	1.3779
Scen2	PI_2	1.0807	1.0343	1.0119	0.9884
	LI_2	1.0133	1.0133	1.0133	1.0133
Scen3	PI_3	1.5493	1.4607	1.4147	1.3645
	LI_3	1.1971	1.1756	1.1613	1.1434
Scen3A	PI_{3A}	1.0679	1.0053	0.9702	0.9332
	LI_{3A}	1.7590	1.7264	1.7014	1.6677
Scen4	PI_4	1.0709	1.0709	1.0709	1.0709
	LI_4	1.0021	1.0021	1.0021	1.0021
Scen5	PI_5	0.9790	0.9790	0.9790	0.9790
	LI_5	0.9942	0.9942	0.9942	0.9942
MOP_{BAL} (rank)		1.1740 (05)	1.1287 (10)	1.1060 (11)	1.0819 (12)
MOP_{BAL7} (rank)		1.1727 (05)	1.1298 (10)	1.1075 (11)	1.0842 (12)
MOL (rank)		1.1688 (09)	1.1628 (10)	1.1585 (11)	1.1520 (12)

TABLE 10: PERFORMANCE AND LETHALITY MEASURES CONFIGURATION 3

Configuration		3A	3B	3C	3D
Scen1	PI_1	1.0456	1.0059	0.9860	0.9660
	LI_1	1.0045	1.0045	1.0045	1.0045
Scen1A	PI_{1A}	1.5102	1.4651	1.4403	1.4188
	LI_{1A}	1.3616	1.3677	1.3724	1.3724
Scen2	PI_2	1.0864	1.0478	1.0277	1.0070
	LI_2	1.0133	1.0133	1.0133	1.0133
Scen3	PI_3	1.6964	1.6150	1.5573	1.5228
	LI_3	1.2545	1.2545	1.2330	1.2079
Scen3A	PI_{3A}	1.1560	1.1288	1.0849	1.0384
	LI_{3A}	1.8622	1.8718	1.8327	1.7847
Scen4	PI_4	1.1325	1.1325	1.1325	1.1325
	LI_4	1.0065	1.0065	1.0065	1.0065
Scen5	PI_5	0.9790	0.9790	0.9790	0.9790
	LI_5	0.9790	0.9790	0.9790	0.9790
MOP_{BAL} (rank)		1.2210 (02)	1.1811 (04)	1.1567 (07)	1.1379 (09)
MOP_{BAL7} (rank)		1.2116 (02)	1.1778 (04)	1.1544 (07)	1.1339 (09)
MOL (rank)		1.1888 (05)	1.1907 (03)	1.1837 (07)	1.1746 (08)

TABLE 11: PERFORMANCE AND LETHALITY MEASURES CONFIGURATION 4

Configuration		4A	4B	4C	4D
Scen1	PI_1	1.0447	1.0085	0.9900	0.9707
	LI_1	1.0031	1.0031	1.0031	1.0031
Scen1A	PI_{1A}	1.5025	1.4610	1.4406	1.4179
	LI_{1A}	1.3616	1.3675	1.3671	1.3671
Scen2	PI_2	1.0872	1.0509	1.0321	1.0119
	LI_2	1.0133	1.0133	1.0133	1.0133
Scen3	PI_3	1.7110	1.6391	1.6011	1.5461
	LI_3	1.2581	1.2581	1.2581	1.2366
Scen3A	PI_{3A}	1.1640	1.1379	1.1259	1.0818
	LI_{3A}	1.8636	1.8733	1.8765	1.8373
Scen4	PI_4	0.9727	0.9727	0.9727	0.9727
	LI_4	1.0065	1.0065	1.0065	1.0065
Scen5	PI_5	0.9301	0.9301	0.9301	0.9301
	LI_5	0.9931	0.9931	0.9931	0.9931
MOP_{BAL} (rank)		**1.2244 (01)**	1.1882 (03)	1.1694 (06)	1.1458 (08)
MOP_{BAL7} (rank)		**1.2132 (01)**	1.1822 (03)	1.1664 (06)	1.1437 (08)
MOL (rank)		1.1891 (04)	1.1910 (02)	**1.1914 (01)**	1.1838 (06)

C. ANALYSIS

The MOPs and MOLs calculated generate rankings which are generally in agreement. Both MOPs rank DIT configuration 4A as the best missile and configuration 3A as the second best missile. However the MOL ranks DIT configuration 4C as the best missile and configuration 4B as the second best missile. By comparison, DIT variant 4A ranks only fourth in lethality increase. However, the overall difference between the measures is very small.

The results show that average velocity has a strong effect on the PIs, as was expected. However, the MOL showed the strong effect of range and altitude improvements of the DIT variants compared to the generic missile in the vertical plane scenarios 3 and 3A. Higher average velocities do not appreciably increase missile lethality. A decrease in TOF, however, may enhance the survivability of the launching platform in head-on and multiple aircraft engagements, and thus higher missile velocities are generally desirable.

DIT technology does not appreciably alter the lethality of an IR SRAAM for non-maneuvering forward aspect engagements because of the seeker lock-on range limit for both scenarios; the small increase comes from a decrease in the minimum launch range and is in reality, negligible. Even Scenario 2 (a head-on shot against a 6g weaving target) still resulted in a seeker limit despite continued maneuvering requirements by the missile to ensure a successful intercept. However, kinematic

improvements with DIT technology can be noted in the TOFs for Scenario 2. Specifically, Configurations 3 and 4 (67/33 and 70/30 mass fraction first to second stage, respectively) still had lower TOFs than the generic missile, which shows less energy depletion than the generic SRAAM, and thus more maneuver energy capability.

For rear aspect engagements, which are inherently kinematically limiting to a missile, the target IR signature increases an order of magnitude [Ref 10], and a definite increase in lethality is noted due to the increased size of the launch envelope. Shoot-up scenario 3 and rear aspect scenarios 1A and 3A show this clearly, as they are all kinematically limiting to the missile. DIT technology increases the engagement range for scenario 1A up to a 37.79% and the vertical capability up to a 25.81% over the generic SRAAM. The most lethal missile, DIT variant 4C, increases Scenario 1A engagement range by 36.71%, and increases the vertical engagement capability for Scenario 3 by 25.81% over the generic SRAAM. Also note that MOP_{BAL} and MOP_{BAL7} yielded identical rankings despite the inclusion of Scenarios 1A and 3A to the MOP_{BAL7} calculations. An interesting trend to note in the data is that the trend in the results for Scenario 3 and 3A PIs and LIs do not agree. The PIs for Scenario 3 are all larger than the PIs for Scenario 3A, whereas the LIs for Scenario 3A are much greater than the LIs for Scenario 3. The

measure of vertical and horizontal increase in the launch envelopes had a major effect on the MOL calculations and hence rankings. It appears that the use of Δh and TOFs for calculating PI_{3A} was inappropriate. For example, Variant 4D was assessed to be an 8.18% better performer kinematically than the baseline missile for Scenario 3A, yet the altitude improvement was 23.66% and the improvement in slant launch range was 48.59% over the baseline missile. Clearly a better PI is required for verical engagements.

Figure 21 is a diagram of the MOPs and MOLs for the 16 variants tested to show trends. It can be seen that for all of the measures, the positive trend is to higher configurations with higher mass fractions in the first stage, with an optimum

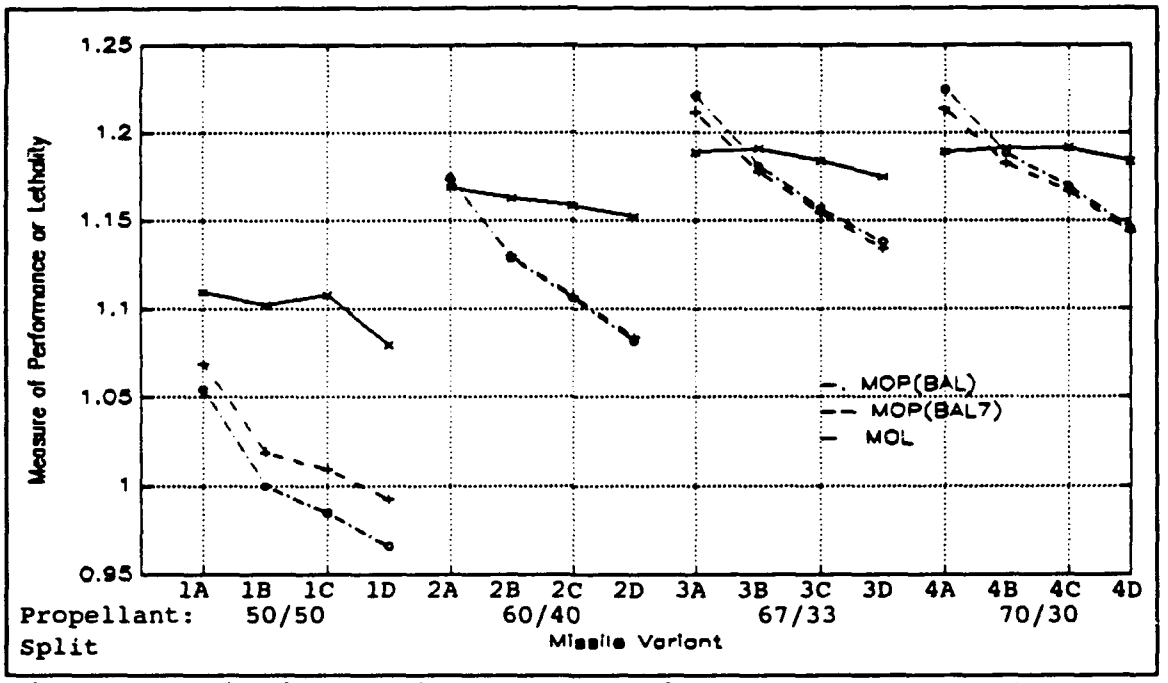

Figure 21 Missile Variants and their Measures of Performance and Lethality

propellant split close to 70/30. However, within each configuration (i.e. the variation in time delay) there is an interesting difference. The MOPs vary significantly over the range of the delays, with the positive trend toward the shortest delay. On the other hand, the MOL has a negligible change with delay. The latter feature implies that the MOL is not strongly dependent upon the particular delay time and consequently, if the real life scenarios are different from those studied herein, the DIT missile should still be more lethal, unconstrained by a specific δ.

VIII. COST AND OPERATIONAL EFFECTIVENESS ANALYSIS

A. GENERAL

The CF has a requirement to upgrade its stock of air-to-air missiles to keep its fighter force effective against emerging threats. A variety of alternatives are available, some involving modifications to existing stock, others involving the purchase of new weapons. The procedure for determining the correct course of action is known as a Cost and Operational Effectiveness Analysis (COEA). A COEA evaluates the costs and benefits (i.e., the operational effectiveness or military utility) of alternative courses of action to meet recognized defense needs [Ref. 11]. The application of DIT technology to current missiles in inventory is one alternative to the procurement of entirely new weapons. This study focuses on the benefits of upgrading an IR SRAAM with DIT technology, and is essentially the effectiveness analysis of a COEA.

B. DIT UPGRADE EFFECTIVENESS

Although the numbers generated in this study cannot be applied to any given missile with certainty, the overall trends are of importance. An improvement of up to 19.14% in lethality was noted using the measures developed for this study by the introduction of DIT motors to the generic SRAAM.

However, for the scenarios deemed critical by CF aircrews, negligible improvements in lethality were noted for the most lethal variant, except for Scenario 3 which showed a 25.81% increase in lethality over the baseline missile. This is due to the seeker limit in forward aspect engagements. The only way to significantly improve forward aspect performance is to improve the seeker. This shows the limitations of DIT technology when applied to an IR SRAAM.

However, this study showed that dramatic improvements can be expected in missile lethality and performance for rear aspect engagements where there is no seeker limit on engagement range. The most lethal variant registers a 36.71% increase in lethality for Scenario 1A which stems from a 35.22% increase in the maximum engagement range. The result of this improvement is a much larger rear aspect launch envelope against a given target. Therefore, DIT technology does improve the lethality of an IR SRAAM, however the full impact of these improvements requires additional modifications (i.e. a new seeker).

The trends in this study suggest that a medium range air-to-air missile (MRAAM) would be able to benefit more from DIT technology. In this study, the scenarios with the longer flight times produced better average velocities and showed the true benefits of DIT motors. Thus, DIT motors may offer superior performance and lethality improvements for MRAAMs

compared to SRAAMs, even in forward aspect engagements, given their longer TOFs than SRAAMs.

C. COST ANALYSIS

Cost estimates are also of importance in making a final decision for the implementation of a DIT upgrade. A cost analysis must still be conducted as it was not a part of this study. This study does show that DIT powered SRAAMs offer an improvement in lethality and performance and hence effectiveness over conventionally powered ones. However, CF aircrews must decide if these advantages are worth the cost of an upgrade, given that the improvements are not significant in four of the five scenarios they deem of primary importance.

IX. SUMMARY AND CONCLUSIONS

In summary, this study has assessed the increase in both kinematic performance and in lethality of a generic IR air-to-air missile due to the introduction of DIT technology to the missile motor. A measure of kinematic improvement was calculated using equations similar to those developed by Bristol Aerospace Limited. A measure of lethality was also calculated using the ratio of the difference between maximum and minimum launch ranges. These assessments were based on the performance of the missiles in five or seven selected scenarios which are a representation of the kinematic capabilities deemed important by CF aircrews.

The BAL measures of performance applied to this study showed kinematic improvements in all configurations over the baseline missile except Configuration 1 (50/50 propellant split). The trends found in this study for DIT motor parameters which maximize kinematic performance are:

- higher first stage mass fractions, the optimum being close to 70/30 (first to second stage); and
- low time delays for all configurations.

It was found that DIT motors do in fact contribute to the lethality of a SRAAM. However, the full performance benefits of DIT technology cannot be realized due to the shorter flight times for the typical SRAAM engagements selected by the CF

aircrews, and the limited maximum seeker lock-on range in forward aspect engagements. The greatest improvements in lethality were noted for rear aspect and shoot-up engagements, which are kinematically limiting to a missile. The trends found in this study for DIT motor parameters which maximize the improvement in missile lethality are:

- higher first stage mass fractions, the optimum being close to 70/30 (first to second stage); and
- relative insensitivity to time delays.

The greatest discrepancy found between the two methods of measuring missile effectiveness was in vertical performance assessment. It appears that the lethality measure developed herein is a better measure for optimization of a DIT motor thrust profile to maximize lethality.

APPENDIX A - TRAP DATA FILES

AEROTBLE.DAT (1 of 28)

```
AERO COEFFS IN METRIC AND PER RAD ( 12/07/87 )
CA VS MACH & ALTITUDE(M) (PWR OFF)
STAGE 1
MACH 17
ALTITUDE 5
9999
     0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
     0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
     0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
     0.4000000E+010.6000000E+01
     0.0000000E+000.1100000E+050.2000000E+050.2500000E+050.3500000E+05
     0.5102242E+000.4991442E+000.4947842E+000.6161640E+000.8391537E+00
     0.1225576E+010.2179790E+010.1280407E+010.1164533E+010.1145412E+01
     0.1016253E+010.9503534E+000.8612486E+000.7556937E+000.6606989E+00
     0.5527291E+000.4900892E+00
     0.5102242E+000.4991442E+000.4947842E+000.6161640E+000.8391537E+00
     0.1225576E+010.2179790E+010.1280407E+010.1164533E+010.1145412E+01
     0.1016253E+010.9503534E+000.8612486E+000.7556937E+000.6606989E+00
     0.5527291E+000.4900892E+00
     0.7246339E+000.6686140E+000.6369540E+000.7484638E+000.9670435E+00
     0.1349477E+010.2298021E+010.1393177E+010.1267747E+010.1240437E+01
     0.1105608E+010.1035823E+010.9441985E+000.8366486E+000.7433338E+00
     0.6415589E+000.5667391E+00
     0.8378237E+000.7693088E+000.7293538E+000.8375037E+000.1054613E+01
     0.1435681E+010.2381286E+010.1473712E+010.1343032E+010.1311732E+01
     0.1173438E+010.1100608E+010.1006148E+010.8926135E+000.7943637E+00
     0.6850289E+000.6047490E+00
     0.9772634E+000.8923686E+000.8420187E+000.9459685E+000.1161188E+01
     0.1540471E+010.2482610E+010.1571677E+010.1434487E+010.1398252E+01
     0.1255862E+010.1179253E+010.1081537E+010.9608634E+000.8568386E+00
     0.7388937E+000.6523139E+00
0000
CA VS MACH & ALTITUDE(M) (PWR ON)
STAGE 1
MACH 17
ALTITUDE 5
9999
     0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
     0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
     0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
     0.4000000E+010.6000000E+01
     0.0000000E+000.1100000E+050.2000000E+050.2500000E+050.3500000E+05
     0.4562242E+000.4461442E+000.4427842E+000.5641640E+000.7781537E+00
     0.1154577E+010.2097791E+010.1201407E+010.1088533E+010.1073413E+01
     0.9482535E+000.8873535E+000.8032486E+000.7096938E+000.6236989E+00
     0.5277291E+000.4680892E+00
     0.4562242E+000.4461442E+000.4427842E+000.5641640E+000.7781537E+00
     0.1154577E+010.2097791E+010.1201407E+010.1088533E+010.1073413E+01
     0.9482535E+000.8873535E+000.8032486E+000.7096938E+000.6236989E+00
     0.5277291E+000.4680892E+00
     0.6706339E+000.6156140E+000.5849540E+000.6964638E+000.9060435E+00
     0.1278478E+010.2216022E+010.1314178E+010.1191748E+010.1168437E+01
     0.1037608E+010.9728234E+000.8861985E+000.7906487E+000.7063338E+00
     0.6165590E+000.5447391E+00
     0.7838237E+000.7163088E+000.6773539E+000.7855037E+000.9936134E+00
     0.1364682E+010.2299286E+010.1394712E+010.1267033E+010.1239733E+01
     0.1105438E+010.1037608E+010.9481484E+000.8466136E+000.7573637E+00
     0.6600289E+000.5827490E+00
     0.9232634E+000.8393686E+000.7900187E+000.8939685E+000.1100188E+01
     0.1469472E+010.2400610E+010.1492678E+010.1358488E+010.1326252E+01
```

```
    0.1187862E+010.1116253E+010.1023538E+010.9148635E+000.8198386E+00
    0.7138938E+000.6303139E+00
0000
CNL VS ALPHA(DEG) & DELTA(DEG) & MACH
STAGE 1
ALPHA 11
DELTA 9
MACH 17
9999
    -.2500000E+02-.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+01
    0.0000000E+000.5000000E+010.1000000E+020.1500000E+020.2000000E+02
    0.2500000E+02
    -.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+010.0000000E+00
    0.5000000E+010.1000000E+020.1500000E+020.2000000E+02
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    -.2040691E+02-.1586570E+02-.1104550E+02-.6880800E+01-.2980000E+01
    -.1062000E+000.1335100E+010.4288100E+010.8136300E+010.1264010E+02
    0.1731160E+02
    -.2030679E+02-.1578640E+02-.1107290E+02-.7113600E+01-.3184700E+01
    -.4054000E+000.1527800E+010.4759900E+010.8740200E+010.1343010E+02
    0.1825880E+02
    -.2012869E+02-.1568360E+02-.1124590E+02-.7051800E+01-.3196900E+01
    -.5070000E+000.1783000E+010.5225700E+010.9384200E+010.1427380E+02
    0.1914481E+02
    -.1991370E+02-.1577180E+02-.1115580E+02-.6690200E+01-.2826800E+01
    -.3597000E+000.2066300E+010.5707600E+010.1006370E+020.1505620E+02
    0.1982080E+02
    -.1989709E+02-.1566840E+02-.1068030E+02-.6220600E+01-.2394400E+01
    0.0000000E+000.2394400E+010.6220600E+010.1068030E+020.1566840E+02
    0.1989709E+02
    -.1982080E+02-.1505620E+02-.1006370E+02-.5707600E+01-.2066300E+01
    0.3597000E+000.2826800E+010.6690200E+010.1115580E+020.1577180E+02
    0.1991370E+02
    -.1914481E+02-.1427380E+02-.9384200E+01-.5225700E+01-.1783000E+01
    0.5070000E+000.3196900E+010.7051800E+010.1124590E+020.1568360E+02
    0.2012869E+02
    -.1825880E+02-.1343010E+02-.8740200E+01-.4759900E+01-.1527800E+01
    0.4054000E+000.3184700E+010.7113600E+010.1107290E+020.1578630E+02
    0.2030679E+02
    -.1731160E+02-.1264010E+02-.8136300E+01-.4288100E+01-.1335100E+01
    0.1062000E+000.2980000E+010.6880800E+010.1104550E+020.1586570E+02
    0.2040691E+02
    -.2229030E+02-.1700510E+02-.1168840E+02-.6969200E+01-.2874700E+01
    0.2840000E-010.1380100E+010.4248900E+010.8482300E+010.1329350E+02
    0.1859930E+02
    -.2215810E+02-.1688670E+02-.1162950E+02-.6985300E+01-.3091000E+01
    -.3111000E+000.1539300E+010.4716900E+010.9115400E+010.1411870E+02
    0.1955540E+02
    -.2191969E+02-.1667410E+02-.1155080E+02-.6984900E+01-.3147000E+01
    -.4652000E+000.1768900E+010.5193000E+010.9782000E+010.1497530E+02
    0.2041541E+02
    -.2158430E+02-.1644640E+02-.1150010E+02-.6652600E+01-.2806000E+01
    -.3573000E+000.2041400E+010.5686200E+010.1046430E+020.1574330E+02
    0.2101630E+02
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    0.0000000E+000.2369200E+010.6199800E+010.1106000E+020.1631580E+02
    0.2123309E+02
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0.2158430E+02
-.2041541E+02-.1497530E+02-.9782000E+01-.5193000E+01-.1768900E+01
0.4652000E+000.3146900E+010.6984900E+010.1155080E+020.1667410E+02
0.2191980E+02
-.1955530E+02-.1411870E+02-.9115400E+01-.4716900E+01-.1539300E+01
0.3111000E+000.3091000E+010.6985300E+010.1162950E+020.1688670E+02
0.2215810E+02
-.1859930E+02-.1329350E+02-.8482300E+01-.4248800E+01-.1380100E+01
-.2840000E-010.2874700E+010.6969200E+010.1168840E+020.1700510E+02
0.2229041E+02
-.2191541E+02-.1671831E+02-.1153660E+02-.7027200E+01-.2897000E+01
-.1629000E+000.1161600E+010.3916300E+010.7932000E+010.1268400E+02
0.1798830E+02
-.2183110E+02-.1660550E+02-.1144770E+02-.6985000E+01-.3097900E+01
-.4265000E+000.1384400E+010.4428600E+010.8590900E+010.1352070E+02
0.1895090E+02
-.2161060E+02-.1637109E+02-.1130050E+02-.6903600E+01-.3118700E+01
-.5061000E+000.1670800E+010.4945100E+010.9288800E+010.1439220E+02
0.1984140E+02
-.2126331E+02-.1607809E+02-.1114660E+02-.6524500E+01-.2775300E+01
-.3566000E+000.1985300E+010.5479100E+010.1000540E+020.1519440E+02
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-.2085350E+02-.1582220E+02-.1064840E+02-.6030500E+01-.2339300E+01
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0.3566000E+000.2775300E+010.6524500E+010.1114660E+020.1607809E+02
0.2126331E+02
-.1984140E+02-.1439220E+02-.9288800E+01-.4945100E+01-.1670800E+01
0.5061000E+000.3118700E+010.6903600E+010.1130050E+020.1637109E+02
0.2161060E+02
-.1895090E+02-.1352070E+02-.8590900E+01-.4428600E+01-.1384400E+01
0.4265000E+000.3097900E+010.6985000E+010.1144770E+020.1660550E+02
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-.3080000E+000.1015700E+010.3749900E+010.7763400E+010.1255190E+02
0.1797070E+02
-.2206770E+02-.1677090E+02-.1161030E+02-.7140100E+01-.3188200E+01
-.5345000E+000.1282400E+010.4307400E+010.8470500E+010.1343250E+02
0.1897211E+02
-.2185201E+02-.1652029E+02-.1142510E+02-.7009900E+01-.3197900E+01
-.5734000E+000.1613900E+010.4873400E+010.9217600E+010.1434470E+02
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-.3877000E+000.1972800E+010.5457500E+010.9980200E+010.1518850E+02
0.2061700E+02
-.2104150E+02-.1586300E+02-.1066850E+02-.6054800E+01-.2369000E+01
0.0000000E+000.2369000E+010.6054800E+010.1066850E+020.1586300E+02
0.2104150E+02
-.2061700E+02-.1518850E+02-.9980200E+01-.5457500E+01-.1972800E+01
0.3877000E+000.2839000E+010.6591300E+010.1121160E+020.1618800E+02
0.2149020E+02
-.1990379E+02-.1434470E+02-.9217600E+01-.4873400E+01-.1613900E+01
0.5734000E+000.3197900E+010.7009900E+010.1142510E+020.1652029E+02
0.2185201E+02
```

```
-.1897211E+02-.1343250E+02-.8470500E+01-.4307400E+01-.1282400E+01
0.5345000E+000.3188200E+010.7140100E+010.1161040E+020.1677090E+02
0.2206770E+02
-.1797070E+02-.1255190E+02-.7763400E+01-.3749900E+01-.1015700E+01
0.3080000E+000.3001300E+010.7215800E+010.1171630E+020.1688190E+02
0.2212810E+02
-.2235471E+02-.1702589E+02-.1182910E+02-.7308800E+01-.2996400E+01
-.3068000E+000.9826000E+000.3694800E+010.7716800E+010.1255370E+02
0.1808290E+02
-.2230760E+02-.1691710E+02-.1171620E+02-.7216900E+01-.3193500E+01
-.5354000E+000.1260100E+010.4269100E+010.8445500E+010.1345450E+02
0.1910280E+02
-.2209531E+02-.1665930E+02-.1151260E+02-.7061600E+01-.3215100E+01
-.5753000E+000.1602800E+010.4854700E+010.9214200E+010.1438520E+02
0.2005470E+02
-.2172690E+02-.1630740E+02-.1126810E+02-.6626400E+01-.2862300E+01
-.3902000E+000.1974000E+010.5458700E+010.9996200E+010.1524840E+02
0.2079581E+02
-.2125850E+02-.1594620E+02-.1070410E+02-.6073400E+01-.2382700E+01
0.0000000E+000.2382700E+010.6073400E+010.1070420E+020.1594610E+02
0.2125850E+02
-.2079581E+02-.1524850E+02-.9996200E+01-.5458700E+01-.1974000E+01
0.3902000E+000.2862300E+010.6626400E+010.1126810E+020.1630740E+02
0.2172690E+02
-.2005470E+02-.1438520E+02-.9214200E+01-.4854700E+01-.1602800E+01
0.5753000E+000.3215100E+010.7061600E+010.1151260E+020.1665930E+02
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    -.1250460E+02-.8998700E+01-.6114400E+01-.3588500E+01-.1307300E+01
    0.1980000E+000.1740200E+010.4153400E+010.6880700E+010.9949400E+01
    0.1374670E+02
    -.1203100E+02-.8619600E+01-.5817900E+01-.3353600E+01-.1096600E+01
    0.4081000E+000.1989700E+010.4497700E+010.7342000E+010.1059750E+02
    0.1429500E+02
    -.1163550E+02-.8307600E+01-.5559000E+01-.3128200E+01-.8726000E+00
    0.6442000E+000.2260900E+010.4879400E+010.7911200E+010.1112400E+02
    0.1467760E+02
    -.1131330E+02-.8042500E+01-.5318700E+01-.2897700E+01-.6203000E+00
    0.9034000E+000.2556400E+010.5324100E+010.8397800E+010.1146180E+02
    0.1496690E+02
    -.1446890E+02-.1085850E+02-.7813900E+01-.4887500E+01-.2417400E+01
    -.8897000E+000.5363000E+000.2609800E+010.4809900E+010.7456600E+01
    0.1081860E+02
    -.1419160E+02-.1052820E+02-.7190700E+01-.4438500E+01-.2090000E+01
    -.6150000E+000.7775000E+000.2810500E+010.5004000E+010.7687000E+01
    0.1110540E+02
    -.1383150E+02-.9845300E+01-.6650900E+01-.4050300E+01-.1801300E+01
    -.3759000E+000.9783000E+000.2998000E+010.5218000E+010.7962600E+01
    0.1146820E+02
    -.1311750E+02-.9236400E+01-.6195500E+01-.3712400E+01-.1550900E+01
    -.1774000E+000.1159600E+010.3195800E+010.5478000E+010.8309300E+01
    0.1191850E+02
    -.1245420E+02-.8735500E+01-.5802600E+01-.3427500E+01-.1343400E+01
    0.0000000E+000.1343300E+010.3427400E+010.5802500E+010.8735400E+01
    0.1245400E+02
    -.1191860E+02-.8309400E+01-.5478100E+01-.3195900E+01-.1159600E+01
    0.1774000E+000.1550800E+010.3712200E+010.6195300E+010.9236200E+01
    0.1311730E+02
    -.1146820E+02-.7962700E+01-.5218000E+01-.2998000E+01-.9783000E+00
    0.3759000E+000.1801200E+010.4050100E+010.6650800E+010.9845100E+01
    0.1383130E+02
    -.1110540E+02-.7687000E+01-.5004000E+01-.2810500E+01-.7775000E+00
    0.6150000E+000.2089800E+010.4438300E+010.7190400E+010.1052800E+02
    0.1419150E+02
    -.1081860E+02-.7466700E+01-.4810000E+01-.2609900E+01-.5363000E+00
    0.8897000E+000.2417400E+010.4887200E+010.7813600E+010.1085840E+02
    0.1446880E+02
0000
CMREF VS ALPHA(DEG) & DELTA(DEG) & MACH
STAGE 1
```

```
ALPHA 11
DELTA 9
MACH 17
9999
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    0.2500000E+02
    -.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+010.0000000E+00
    0.5000000E+010.1000000E+020.1500000E+020.2000000E+02
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    0.2580791E+020.1122170E+02-.3489500E+01-.1655220E+02-.3104860E+02
    -.3701469E+02-.3034940E+02-.2828490E+02-.3089410E+02-.3688460E+02
    -.4425450E+02
    0.2688589E+020.1285230E+02-.1846800E+01-.1696410E+02-.2652020E+02
    -.2751120E+02-.2224640E+02-.2125670E+02-.2526030E+02-.3154640E+02
    -.3919370E+02
    0.2828281E+020.1440610E+02-.2139900E+01-.1401500E+02-.1826550E+02
    -.1727589E+02-.1359540E+02-.1449640E+02-.1909911E+02-.2574631E+02
    -.3440030E+02
    0.2977260E+020.1437430E+020.3960000E-01-.7693200E+01-.1047630E+02
    -.7723200E+01-.5536900E+01-.7426200E+01-.1230220E+02-.2018980E+02
    -.3065109E+02
    0.3008031E+020.1558530E+020.5705100E+01-.2886000E+00-.2413100E+01
    0.0000000E+000.2413100E+010.2886000E+00-.5705100E+01-.1558520E+02
    -.3000031E+02
    0.3065100E+020.2018980E+020.1230220E+020.7426200E+010.5536900E+01
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    -.2977260E+02
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    -.2828281E+02
    0.3919370E+020.3154649E+020.2526030E+020.2125670E+020.2224640E+02
    0.2751120E+020.2652020E+020.1696420E+020.1846900E+01-.1285220E+02
    -.2688600E+02
    0.4425450E+020.3688460E+020.3089410E+020.2828490E+020.3034940E+02
    0.3701469E+020.3104860E+020.1655231E+020.3489500E+01-.1122160E+02
    -.2580791E+02
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    -.3834500E+02-.3196111E+02-.2949091E+02-.3193150E+02-.3755220E+02
    -.4452260E+02
    0.2370309E+020.9771500E+01-.4424200E+01-.1672099E+02-.2715840E+02
    -.2895740E+02-.2373090E+02-.2207930E+02-.2587460E+02-.3191949E+02
    -.3937421E+02
    0.2553081E+020.1229350E+02-.1818700E+01-.1444630E+02-.1899100E+02
    -.1847321E+02-.1458200E+02-.1479010E+02-.1930389E+02-.2596899E+02
    -.3468201E+02
    0.2776390E+020.1464380E+020.4720000E-01-.8296100E+01-.1107910E+02
    -.8333500E+01-.5867400E+01-.7202800E+01-.1223240E+02-.2045000E+02
    -.3131110E+02
    0.2995689E+020.1607339E+020.5582400E+01-.8499000E+00-.2677800E+01
    0.0000000E+000.2677800E+010.8499000E+00-.5582400E+01-.1607339E+02
    -.2995689E+02
    0.3131110E+020.2045010E+020.1223230E+020.7202800E+010.5867400E+01
    0.8333500E+010.1107910E+020.8296000E+01-.4720000E-01-.1464390E+02
    -.2776390E+02
    0.3468190E+020.2596899E+020.1930389E+020.1479010E+020.1458200E+02
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-.2370309E+02
0.4452251E+020.3755231E+020.3193140E+020.2949080E+020.3196120E+02
0.3834500E+020.3063451E+020.1926860E+020.7364600E+01-.7648200E+01
-.2233080E+02
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-.3486200E+01
0.2374370E+020.2054581E+020.1875301E+020.1942010E+020.2471159E+02
0.3388750E+020.3497940E+020.2605859E+020.1858580E+020.8823000E+01
-.1931100E+01
0.2959200E+020.2690050E+020.2554950E+020.2718840E+020.3364120E+02
0.4513690E+020.4419710E+020.3048610E+020.2192560E+020.1065380E+02
-.1480500E+01
0.3228500E+01-.8354200E+01-.1877670E+02-.2717970E+02-.4102750E+02
-.4008170E+02-.2886040E+02-.2437379E+02-.2533701E+02-.2957460E+02
-.3506920E+02
0.5236000E+01-.4952900E+01-.1388280E+02-.2095711E+02-.2892780E+02
-.2849860E+02-.2095869E+02-.1851331E+02-.2078770E+02-.2516589E+02
-.3061830E+02
0.8195900E+01-.6990000E+00-.8273400E+01-.1404720E+02-.1839000E+02
-.1763600E+02-.1318740E+02-.1294400E+02-.1574040E+02-.2019881E+02
-.2585660E+02
0.1194640E+020.4187700E+01-.2224400E+01-.6850500E+01-.9525700E+01
-.8020000E+01-.5938400E+01-.6974400E+01-.1005670E+02-.1488660E+02
-.2100310E+02
0.1628940E+020.9467000E+010.3980200E+010.2732000E+00-.1475900E+01
0.0000000E+000.1478100E+01-.2712000E+00-.3978400E+01-.9465500E+01
-.1628841E+02
0.2100369E+020.1488750E+020.1005740E+020.6974700E+010.5937800E+01
0.8019900E+010.9530800E+010.6854300E+010.2227500E+01-.4185400E+01
-.1194480E+02
0.2585690E+020.2019901E+020.1574030E+020.1294300E+020.1318390E+02
0.1763510E+020.1840021E+020.1405280E+020.8277800E+010.7021000E+00
-.8194000E+01
0.3961819E+020.2516560E+020.2078680E+020.1851070E+020.2095180E+02
0.2849640E+020.2894580E+020.2096449E+020.1388860E+020.4956800E+01
-.5233500E+01
0.3507080E+020.2957600E+020.2533810E+020.2437379E+020.2885699E+02
0.4008859E+020.4106760E+020.2719540E+020.1879010E+020.8363800E+01
-.3222400E+01
0.1514660E+020.4421900E+01-.5972300E+01-.1502030E+02-.2447000E+02
-.2623959E+02-.2194370E+02-.2096761E+02-.2343810E+02-.2840630E+02
-.3378970E+02
0.1572500E+020.5972200E+01-.3341000E+01-.1116480E+02-.1794470E+02
-.1941521E+02-.1672400E+02-.1663930E+02-.1989101E+02-.2508099E+02
-.3059270E+02
0.1700909E+020.8214800E+01-.7319999E-01-.6746800E+01-.1180390E+02
-.1255020E+02-.1113990E+02-.1238270E+02-.1608321E+02-.2145560E+02
-.2736440E+02
0.1892960E+020.1103380E+020.3675500E+01-.1967200E+01-.5890800E+01
-.5867900E+01-.5730800E+01-.7895500E+01-.1190350E+02-.1781740E+02
-.2424310E+02
0.2138370E+020.1428790E+020.7729600E+010.2956800E+010.1522000E+00
0.0000000E+00-.1504000E+00-.2955200E+01-.7728200E+01-.1428690E+02
-.2138290E+02
0.2424361E+020.1781790E+020.1190420E+020.7895700E+010.5730400E+01
0.5867800E+010.5894600E+010.1970000E+01-.3673200E+01-.1103230E+02
```

-.1892870E+02
0.2736459E+020.2145570E+020.1608321E+020.1238200E+020.1113750E+02
0.1254970E+020.1181010E+020.6751000E+010.7620001E-01-.8212700E+01
-.1700790E+02
0.3059270E+020.2508070E+020.1989050E+020.1663750E+020.1671941E+02
0.1941409E+020.1795509E+020.1117030E+020.3344900E+01-.5969800E+01
-.1572360E+02
0.3378951E+020.2840581E+020.2343700E+020.2096480E+020.2193719E+02
0.2623750E+020.2448579E+020.1502710E+020.5977100E+01-.4419000E+01
-.1514500E+02
0.1382980E+020.4704400E+01-.4523200E+01-.1241930E+02-.1970670E+02
-.2117220E+02-.1863499E+02-.1820320E+02-.2109770E+02-.2577240E+02
-.3094521E+02
0.1448620E+020.6177400E+01-.2130200E+01-.9001200E+01-.1449790E+02
-.1567160E+02-.1402900E+02-.1472080E+02-.1809560E+02-.2302409E+02
-.2806500E+02
0.1574790E+020.8226900E+010.7878000E+00-.5140600E+01-.9503900E+01
-.9842900E+01-.9623900E+01-.1117200E+02-.1491410E+02-.1992070E+02
-.2517120E+02
0.1755119E+020.1074710E+020.4093800E+01-.1017300E+01-.4234100E+01
-.4705300E+01-.5210300E+01-.7450700E+01-.1138900E+02-.1669000E+02
-.2238390E+02
0.1980141E+020.1361400E+020.7632800E+010.3396100E+010.6427000E+00
0.0000000E+00-.6413000E+00-.3395100E+01-.7631800E+01-.1361330E+02
-.1980090E+02
0.2238420E+020.1669040E+020.1138940E+020.7450900E+010.5210100E+01
0.4705300E+010.4237200E+010.1019400E+01-.4092100E+01-.1074600E+02
-.1755051E+02
0.2517140E+020.1992070E+020.1491400E+020.1117140E+020.9622200E+01
0.9842700E+010.9508800E+010.5143900E+01-.7855000E+00-.8225300E+01
-.1574700E+02
0.2806500E+020.2302390E+020.1809509E+020.1471940E+020.1402570E+02
0.1567090E+020.1450540E+020.9005600E+010.2133200E+01-.6175400E+01
-.1448510E+02
0.3094501E+020.2577200E+020.2109680E+020.1820100E+020.1863010E+02
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-.1382850E+02
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-.1838190E+02-.1657330E+02-.1678070E+02-.1995810E+02-.2427831E+02
-.2933900E+02
0.1292830E+020.5622500E+01-.1625600E+01-.7792500E+01-.1251660E+02
-.1319680E+02-.1261910E+02-.1374600E+02-.1732950E+02-.2184920E+02
-.2682600E+02
0.1443380E+020.7767400E+010.1296400E+01-.4092200E+01-.7722800E+01
-.8292300E+01-.8845500E+01-.1067000E+02-.1453160E+02-.1913850E+02
-.2395230E+02
0.1639130E+020.1028920E+020.4499300E+01-.7560003E-01-.3057600E+01
-.3981800E+01-.5075100E+01-.7438400E+01-.1144890E+02-.1603290E+02
-.2126060E+02
0.1870300E+020.1307380E+020.7934700E+010.3915200E+010.1159400E+01
0.0000000E+00-.1158300E+01-.3914400E+01-.7934000E+01-.1307320E+02
-.1870250E+02
0.2126089E+020.1603310E+020.1144920E+020.7438500E+010.5074900E+01
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-.1639070E+02
0.2395239E+020.1913860E+020.1453160E+020.1066950E+020.8844200E+01
0.8292100E+010.7726800E+010.4095000E+01-.1294400E+01-.7766200E+01
-.1443300E+02
0.2682600E+020.2184900E+020.1732899E+020.1374480E+020.1261650E+02
0.1319640E+020.1252270E+020.7796200E+010.1628300E+01-.5620900E+01

```
-.1292730E+02
0.2933890E+020.2427800E+020.1995740E+020.1677890E+020.1656931E+02
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-.1194920E+02
0.3871300E+010.6705000E+00-.3486400E+01-.8451800E+01-.1345640E+02
-.1351770E+02-.1293690E+02-.1375760E+02-.1583950E+02-.1799170E+02
-.1989011E+02
0.5008900E+010.2303200E+01-.1197600E+01-.5433500E+01-.8788100E+01
-.9538700E+01-.1014780E+02-.1161400E+02-.1399150E+02-.1621809E+02
-.1799339E+02
0.6573100E+010.4301600E+010.1283000E+01-.1616600E+01-.4738100E+01
-.6065200E+01-.7454300E+01-.9435800E+01-.1201610E+02-.1423600E+02
-.1577990E+02
0.8482400E+010.6513900E+010.4414700E+010.1743400E+01-.1217100E+01
-.2945500E+01-.4742300E+01-.7134300E+01-.9836000E+01-.1195060E+02
-.1310640E+02
0.1061900E+020.9225900E+010.7347000E+010.4611800E+010.1895100E+01
0.0000000E+00-.1894300E+01-.4611300E+01-.7346700E+01-.9225800E+01
-.1061880E+02
0.1310630E+020.1195060E+020.9836100E+010.7134400E+010.4742200E+01
0.2945500E+010.1218900E+01-.1742400E+01-.4414100E+01-.6513500E+01
-.8482100E+01
0.1577990E+020.1423600E+020.1201600E+020.9435500E+010.7453500E+01
0.6065100E+010.4740900E+010.1618100E+01-.1281800E+01-.4300900E+01
-.6572800E+01
0.1799330E+020.1621800E+020.1399130E+020.1161340E+020.1014630E+02
0.9538600E+010.8792200E+010.5436000E+010.1199200E+01-.2302300E+01
-.5008500E+01
0.1989000E+020.1799159E+020.1583910E+020.1375660E+020.1293460E+02
0.1351740E+020.1345660E+020.8455100E+010.3488400E+01-.6694000E+00
-.3870800E+01
0.4302300E+010.8202000E+00-.2348800E+01-.6788600E+01-.1022740E+02
-.1077570E+02-.1138930E+02-.1293360E+02-.1525100E+02-.1737140E+02
-.2050270E+02
0.5629300E+010.2523600E+01-.1744000E+00-.3066900E+01-.6394000E+01
-.7503000E+01-.9096500E+01-.1119060E+02-.1374780E+02-.1588860E+02
-.1886169E+02
0.7337500E+010.4510000E+010.2775600E+010.3483000E+00-.2969900E+01
-.4703300E+01-.6928100E+01-.9435400E+01-.1213600E+02-.1420490E+02
-.1692450E+02
0.9342400E+010.7036800E+010.5814600E+010.3138300E+01-.3250000E-01
-.2268600E+01-.4766500E+01-.7579000E+01-.1033180E+02-.1224030E+02
-.1465510E+02
0.1169880E+020.9959200E+010.8241500E+010.5519900E+010.2491900E+01
0.0000000E+00-.2491300E+01-.5519600E+01-.8241300E+01-.9959100E+01
-.1169880E+02
0.1465510E+020.1224030E+020.1033180E+020.7579000E+010.4766500E+01
0.2268600E+010.3380000E-01-.3137600E+01-.5814200E+01-.7036600E+01
-.9342100E+01
0.1692450E+020.1420490E+020.1213600E+020.9435200E+010.6927600E+01
0.4703300E+010.2972100E+01-.3472000E+00-.2775100E+01-.4509500E+01
-.7337200E+01
0.1886160E+020.1588850E+020.1374770E+020.1119010E+020.9095400E+01
0.7503000E+010.6397000E+010.3068600E+010.1755000E+00-.2523000E+01
-.5628800E+01
0.2050259E+020.1737120E+020.1525070E+020.1293290E+020.1138770E+02
0.1077560E+020.1022720E+020.6791400E+010.2350400E+01-.8193000E+00
-.4301700E+01
0.2978000E+01-.1105300E+01-.3599300E+01-.5772900E+01-.7130500E+01
-.7473600E+01-.7914300E+01-.9351300E+01-.1163210E+02-.1441060E+02
```

```
    -.1867799E+02
    0.4377800E+010.6296000E+00-.8721000E+00-.2638000E+01-.4291000E+01
    -.5200100E+01-.6259000E+01-.8059400E+01-.1053860E+02-.1327400E+02
    -.1735139E+02
    0.6117400E+010.3120000E+010.2056700E+01-.8999997E-01-.1864500E+01
    -.3241300E+01-.4780600E+01-.6792900E+01-.9354500E+01-.1192960E+02
    -.1571650E+02
    0.8500500E+010.6064600E+010.4340700E+010.2085300E+010.1709000E+00
    -.1557800E+01-.3351900E+01-.5451900E+01-.7983000E+01-.1028210E+02
    -.1374610E+02
    0.1148420E+020.8318100E+010.6314000E+010.3927400E+010.1857300E+01
    0.0000000E+00-.1857000E+01-.3927100E+01-.6313900E+01-.8318100E+01
    -.1148410E+02
    0.1374610E+020.1028220E+020.7983000E+010.5452000E+010.3352000E+01
    0.1557800E+01-.1703000E+00-.2084900E+01-.4340400E+01-.6064400E+01
    -.8500400E+01
    0.1571650E+020.1192950E+020.9354400E+010.6792800E+010.4780400E+01
    0.3241300E+010.1865600E+010.9059997E-01-.2056300E+01-.3119800E+01
    -.6117000E+01
    0.1735139E+020.1327390E+020.1053850E+020.8059200E+010.6258500E+01
    0.5200100E+010.4292700E+010.2639100E+010.8727000E+00-.6290000E+00
    -.4377400E+01
    0.1867799E+020.1441050E+020.1163190E+020.9350900E+010.7913500E+01
    0.7473500E+010.7130300E+010.5774300E+010.3600400E+010.1106100E+01
    -.2977500E+01
    0.1527500E+01-.2816900E+01-.5035400E+01-.5670900E+01-.6146900E+01
    -.5970500E+01-.6190900E+01-.7492700E+01-.9603500E+01-.1239010E+02
    -.1708260E+02
    0.2865600E+01-.1165400E+01-.1789000E+01-.2851900E+01-.3695900E+01
    -.4049800E+01-.4788100E+01-.6455800E+01-.8726700E+01-.1144830E+02
    -.1591230E+02
    0.4498300E+010.1957800E+010.9315000E+00-.4883000E+00-.1621500E+01
    -.2444600E+01-.3616600E+01-.5474200E+01-.7753300E+01-.1026550E+02
    -.1442590E+02
    0.7550100E+010.4690600E+010.3162900E+010.1508700E+010.7260001E-01
    -.1145800E+01-.2538400E+01-.4414300E+01-.6556400E+01-.8766600E+01
    -.1256870E+02
    0.1034020E+020.6906300E+010.5038500E+010.3135600E+010.1407900E+01
    0.0000000E+00-.1407600E+01-.3135500E+01-.5038400E+01-.6906300E+01
    -.1034020E+02
    0.1256880E+020.8766600E+010.6556400E+010.4414300E+010.2538400E+01
    0.1145800E+01-.7220000E-01-.1508400E+01-.3162800E+01-.4690400E+01
    -.7550000E+01
    0.1442590E+020.1026550E+020.7753200E+010.5474100E+010.3616500E+01
    0.2444600E+010.1622200E+010.4888000E+00-.9312000E+00-.1957700E+01
    -.4498000E+01
    0.1591220E+020.1144820E+020.8726700E+010.6455600E+010.4787800E+01
    0.4049800E+010.3697000E+010.2852700E+010.1789500E+010.1165900E+01
    -.2865200E+01
    0.1708260E+020.1239000E+020.9603300E+010.7492400E+010.6190400E+01
    0.5970500E+010.6146700E+010.5671900E+010.5036200E+010.2817600E+01
    -.1526900E+01
0000
CNTRIM VS ALPHATRIM(DEG) & MACH
STAGE 1
ALPHA 11
MACH 17
9999
    -.2500000E+02-.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+01
    0.0000000E+000.5000000E+010.1000000E+020.1500000E+020.2000000E+02
```

```
    0.2500000E+02
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    0.0000000E+000.0000000E+00-.1115740E+02-.6201400E+01-.2294800E+01
    0.0000000E+000.2294800E+010.6201400E+010.1115740E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1150140E+02-.6145600E+01-.2266500E+01
    0.0000000E+000.2266500E+010.6145600E+010.1150140E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1100380E+02-.5938200E+01-.2223600E+01
    0.0000000E+000.2223600E+010.5938200E+010.1100380E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1090940E+02-.5896000E+01-.2225700E+01
    0.0000000E+000.2225700E+010.5896000E+010.1090950E+020.0000000E+00
    0.0000000E+00
    0.0000000E+00-.1696330E+02-.1088150E+02-.5881700E+01-.2228600E+01
    0.0000000E+000.2228600E+010.5881700E+010.1088150E+020.1696320E+02
    0.0000000E+00
    0.0000000E+00-.1715390E+02-.1091570E+02-.5892500E+01-.2241100E+01
    0.0000000E+000.2241100E+010.5892500E+010.1091570E+020.1715390E+02
    0.0000000E+00
    0.0000000E+00-.1766650E+02-.1113000E+02-.5984100E+01-.2277100E+01
    0.0000000E+000.2277100E+010.5984100E+010.1113000E+020.1766650E+02
    0.0000000E+00
    0.0000000E+00-.1760719E+02-.1107120E+02-.5954300E+01-.2277800E+01
    0.0000000E+000.2277800E+010.5954300E+010.1107120E+020.1760719E+02
    0.0000000E+00
    0.0000000E+00-.1713060E+02-.1077050E+02-.5811800E+01-.2241700E+01
    0.0000000E+000.2241700E+010.5811800E+010.1077050E+020.1713060E+02
    0.0000000E+00
    0.0000000E+00-.1741080E+02-.1069750E+02-.5712900E+01-.2178200E+01
    0.0000000E+000.2177600E+010.5711900E+010.1069630E+020.1740961E+02
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1058740E+02-.5664300E+01-.2181300E+01
    0.0000000E+000.2180800E+010.5663400E+010.1058630E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1039100E+02-.5514000E+01-.2141000E+01
    0.0000000E+000.2140500E+010.5513200E+010.1039010E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.1030680E+02-.5436800E+01-.2123600E+01
    0.0000000E+000.2123200E+010.5436100E+010.1030590E+020.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.9511000E+01-.5302700E+01-.2111600E+01
    0.0000000E+000.2111200E+010.5302100E+010.9510500E+010.0000000E+00
    0.0000000E+00
    0.0000000E+000.0000000E+00-.9128200E+01-.5271400E+01-.2066900E+01
    0.0000000E+000.2066500E+010.5270900E+010.9127700E+010.0000000E+00
    0.0000000E+00
    0.0000000E+00-.1124680E+02-.7742000E+01-.4483600E+01-.1761300E+01
    0.0000000E+000.1761100E+010.4483300E+010.7741600E+010.1124650E+02
    0.0000000E+00
    0.0000000E+00-.1027340E+02-.6835800E+01-.3967700E+01-.1561600E+01
    0.0000000E+000.1561400E+010.3967400E+010.6835500E+010.1027310E+02
    0.0000000E+00
0000
ALPHAMAX(DEG) VS MACH
STAGE 1
MACH 17
```

```
9999
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    0.1618600E+020.1745276E+020.1877582E+020.1984364E+020.2042174E+02
    0.2153358E+020.2337451E+020.2469740E+020.2438994E+020.2360938E+02
    0.1787468E+020.1745262E+020.1755786E+020.1919501E+020.1870760E+02
    0.2135431E+020.2324271E+02
0000
CNTRIMMAX VS MACH
STAGE 1
MACH 17
9999
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    0.1218886E+020.1429653E+020.1544964E+020.1672035E+020.1747537E+02
    0.1917711E+020.2260840E+020.2478896E+020.2378485E+020.2292667E+02
    0.1413017E+020.1325908E+020.1311873E+020.1301638E+020.1184094E+02
    0.1241120E+020.1319990E+02
0000
CADELT VS ALPHA(DEG) & DELTA(DEG) & MACH
STAGE 1
ALPHA 11
DELTA 9
MACH 17
9999
    -.2500000E+02-.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+01
    0.0000000E+000.5000000E+010.1000000E+020.1500000E+020.2000000E+02
    0.2500000E+02
    -.2000000E+02-.1500000E+02-.1000000E+02-.5000000E+010.0000000E+00
    0.5000000E+010.1000000E+020.1500000E+020.2000000E+02
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
    0.3017599E+010.2719799E+010.2251100E+010.1807799E+010.1473499E+01
    0.1192100E+010.8955001E+000.6244000E+000.4315000E+000.2599000E+00
    -.6059998E-01
    0.2289099E+010.2031699E+010.1610000E+010.1218100E+010.9366997E+00
    0.7095002E+000.4705001E+000.2635000E+000.1422001E+000.4740000E-01
    -.1939999E+00
    0.1578899E+010.1380699E+010.1024099E+010.7006997E+000.4876000E+00
    0.3284000E+000.1602000E+000.3030002E-01-.6799996E-02-.1289999E-01
    -.1649000E+00
    0.9384001E+000.8151997E+000.5390000E+000.2978000E+000.1650000E+00
    0.8420002E-01-.3899992E-02-.4809999E-010.7200003E-020.9630001E-01
    0.3870004E-01
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    0.4133000E+00
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-.4879000E+00
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0.2022599E+01
0.1797400E+010.1631599E+010.1457000E+010.1264700E+010.1057000E+01
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0.1337999E+01
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    0.7477002E+00
0000
DELTRM VS ALPHATRIM(DEG) & MACH
STAGE 1
ALPHA 11
MACH 17
9999
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    0.2500000E+02
    0.4000000E+000.6000000E+000.8000000E+000.9000000E+000.9500000E+00
    0.1000000E+010.1050000E+010.1100000E+010.1200000E+010.1400000E+01
    0.1600000E+010.1800000E+010.2000000E+010.2500000E+010.3000000E+01
    0.4000000E+010.6000000E+01
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    0.0000000E+00-.1517673E+01-.1870441E+000.5090846E+010.0000000E+00
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    0.0000000E+00
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0000
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SAERO.DAT

MISSILE AERO DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TYAERP	NON-LINEAR	-	PITCH AERO TYPE:UNKNOWN,LINEAR, NON-LINEAR (NON-LINEAR)
TYAERY	NON-LINEAR	-	YAW AERO TYPE:UNKNOWN,LINEAR,NON-LINEAR (NON-LINEAR)
TYAERR	UNKNOWN	-	ROLL AERO TYPE:UNKNOWN,LINEAR (UNKNOWN)
TIMCNT	0.	SEC	TIME AFTER LAUNCH THAT CONTROLS ARE UNLOCKED (0.0)
AREA	0.0127	M**2	REFERENCE AREA,CROSS SECTIONAL AREA(1.0)
LONREF	0.127	M	MISSILE LONGITUDINAL AERO REFERENCE LENGTH, DIAMETER (1.0)
LATREF	0.127	M	MISSILE LATERAL AERO REFERENCE LENGTH, DIAMETER (1.0)
REFCG	1.35	M	CENTER-OF-GRAVITY AFT OF NOSE WHERE AERO WAS GENERATED (1.0)
MAXDEL	DEFAULT	DEG	MAX CONTROL SURFACE DEFLECTION ANGLE, IF DEFAULT, TABLE MAX USED (9999.0)
MDELR	DEFAULT	DEG	MAX ROLL CONTROL SURFACE DEFLECTION ANGLE, IF DEFAULT, TABLE MAX USED(9999.)
MAXALP	DEFAULT	DEG	MAX ANGLE-OF-ATTACK, IF DEFAULT, TABLE MAX USED (9999.0)
MAXBET	DEFAULT	DEG	MAX SIDESLIP ANGLE, IF DEFAULT, TABLE MAX USED (9999.0)
DSTACC	DEFAULT	M	DISTANCE FROM NOSE TO MIDSHIP ACCELEROMETER (1.0)
DSTFAC	DEFAULT	M	DISTANCE FROM NOSE TO FORWARD ACCELEROMETER (1.0)
DALPLN	0.0	DEG	PITCH ANGLE BETWEEN MISSILE AND A/C AXES (0.0)
ADOTMX	3.0	RAD/S	MAX RATE OF CHANGE OF ALPHA FOR POINT-MASS (3.0)
BDOTMX	3.0	RAD/S	MAX RATE OF CHANGE OF BETAT FOR POINT-MASS (3.0)

SAUTOP.DAT (1 of 4)

MISSILE AUTOPILOT AND CONTROLLER DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TYPAPP	UNKNOWN	-	TYPE OF PITCH AUTOPILOT:UNKNOWN,ACCEL1, ACCEL2,SYN-STAB,BODY-RATE,BODY-ATT (UNKNOWN)
TYPAPY	UNKNOWN	-	TYPE OF YAW AUTOPILOT:UNKNOWN,TORQUE-BAL THRUST-VECT,FIN-POS,ALPHA-BETA (UNKNOWN)
TYPAPR	UNKNOWN	-	TYPE OF ROLL AUTOPILOT:UNKNOWN, THRUST-VECT (UNKNOWN)
TYPCSP	CANARD-COMM	-	PITCH CONTROL TYPE:TAIL-COMM,WING-COMM, CANARD-COMM,UNKNOWN (TAIL-COMM)
TYPCSY	CANARD-COMM	-	YAW CONTROL TYPE:TAIL-COMM,WING-COMM, CANARD-COMM,UNKNOWN (TAIL-COMM)
TYPCSR	UNKNOWN	-	ROLL CONTROL TYPE:TAIL-COMM,WING-COMM, CANARD-COMM,UNKNOWN (UNKNOWN)
MXHGCG	33.	G	MAX STRUCTURAL GS IN PLANE OF HORIZONTAL FINS (30.)
MXVGCG	33.	G	MAX STRUCTURAL GS IN PLANE OF VERTICAL FINS (30.)
PMRK	DEFAULT	-	GAIN ON ALTITUDE AND CROSSRANGE RATES (0.0)
ACDY	DEFAULT	-	TRSFR FNCTN FOR MISSILE CONTROLLER:1/S, PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
ACK	DEFAULT	-	CONTROLLER GAIN (1.0)
ACNT	DEFAULT	SEC	CONTROLLER LEAD TIME CONSTANT (0.0)
ACTC	DEFAULT	SEC	CONTROLLER LAG TIME CONSTANT (0.0)
ACW2	DEFAULT	R**2/S**2	CONTROLLER 2ND ORDER LAG OMEGA**2 TERM (0.0)
ACZW	DEFAULT	R/S	CONTROLLER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
PLCONF	FALSE	-	TRUE IF MISSILE FLYS IN +-CONFIGURATION (TRUE)
XCONF	TRUE	-	TRUE IF MISSILE FLYS IN X-CONFIGURATION (FALSE)
MACCS	DEFAULT	M	MEAN AERO CHORD OF CONTROL SURFACE (1.0)
AREACS	DEFAULT	M**2	PLANFORM AREA OF CONTROL SURFACE (1.0)
AACDY	DEFAULT	-	TRSFR FNCTN FOR ACTUATOR:1/S,1-LAG, PURE-GAIN,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AACK	DEFAULT	-	ACTUATOR GAIN (1.0)
AACNT	DEFAULT	SEC	ACTUATOR LEAD TIME CONSTANT (0.0)
AACTC	DEFAULT	SEC	ACTUATOR LAG TIME CONSTANT (0.0)
AACW2	DEFAULT	R**2/S**2	ACTUATOR 2ND ORDER LAG OMEGA**2 TERM (0.0)
AACZW	DEFAULT	R/S	ACTUATOR 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
ARFDY	DEFAULT	-	TRSFR FNCTN FOR RATE-LOOP FORWARD PATH FILTER:1/S,PURE-GAIN,1-LAG,2-LAG, 1-LEAD,1-LAG,1-LEAD-2-LAG (PURE-GAIN)
ARFK	DEFAULT	-	RATE FORWARD FILTER GAIN (1.0)
ARFNT	DEFAULT	SEC	RATE FORWARD FILTER LEAD TIME CONSTANT (0.0)
ARFTC	DEFAULT	SEC	RATE FORWARD FILTER LAG TIME CONSTANT (0.0)
ARFW2	DEFAULT	R**2/S**2	RATE FORWARD FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
ARFZW	DEFAULT	R/S	RATE FORWARD FILTER 2ND ORDER LAG

			ZETA*OMEGA TERM (0.0)
ARGDY	DEFAULT	-	TRSFR FNCTN FOR RATE-GYRO DYNAMICS:1/S, PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
ARGK	DEFAULT	-	RATE GYRO DYNAMICS GAIN (1.0)
ARGNT	DEFAULT	SEC	RATE GYRO DYNAMICS LEAD TIME CONSTANT (0.0)
ARGTC	DEFAULT	SEC	RATE GYRO DYNAMICS LAG TIME CONSTANT (0.0)
ARGW2	DEFAULT	R**2/S**2	RATE GYRO DYNAMICS 2ND ORDER LAG OMEGA**2 TERM (0.0)
ARGZW	DEFAULT	R/S	RATE GYRO DYNAMICS 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
ARFBDY	DEFAULT	-	TRSFR FNCTN FOR RATE-LOOP FEEDBACK PATH FILTER:1/S,1-LAG,2-LAG,1-LEAD-1-LAG, PURE-GAIN,1-LEAD-2-LAG (PURE-GAIN)
ARFBK	DEFAULT	-	RATE FEEDBACK FILTER GAIN (1.0)
ARFBNT	DEFAULT	SEC	RATE FEEDBACK FILTER LEAD TIME CONSTANT (0.0)
ARFBTC	DEFAULT	SEC	RATE FEEDBACK FILTER LAG TIME CONSTANT (0.0)
ARFBW2	DEFAULT	R**2/S**2	RATE FEEDBACK FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
ARFBZW	DEFAULT	R/S	RATE FEEDBACK FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AAFDY	DEFAULT	-	TRSFR FNCTN FOR FORWARD PATH FILTER FOR ATTITUDE TYPE AUTOPILOTS:1/S,PURE-GAIN, 1-LAG,2-LAG,1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
AAFK	DEFAULT	-	FORWARD ATTITUDE FILTER GAIN (1.0)
AAFNT	DEFAULT	SEC	FORWARD ATTITUDE FILTER LEAD TIME CONSTANT (0.0)
AAFTC	DEFAULT	SEC	FORWARD ATTITUDE FILTER LAG TIME CONSTANT (0.0)
AAFW2	DEFAULT	R**2/S**2	FORWARD ATTITUDE FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AAFZW	DEFAULT	R/2	FORWARD ATTITUDE FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.)
AGF1DY	DEFAULT	-	TRSFR FNCTN FOR MIDSHIP ACCELERATION LOOP FORWARD PATH FILTER:1/S,PURE-GAIN, 1-LAG,2-LAG,1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
AGF1K	DEFAULT	-	MIDSHIP ACCEL FORWARD FILTER GAIN (1.0)
AGF1NT	DEFAULT	SEC	MIDSHIP ACCEL FORWARD FILTER LEAD TIME CONSTANT (0.0)
AGF1TC	DEFAULT	SEC	MIDSHIP ACCEL FORWARD FILTER LAG TIME CONSTANT (0.0)
AGF1W2	DEFAULT	R**2/S**2	MIDSHIP ACCEL FORWARD FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AGF1ZW	DEFAULT	R/S	MIDSHIP ACCEL FORWARD FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AA1DY	DEFAULT	-	TRSFR FNCTN FOR MIDSHIP ACCELEROMETER: PURE-GAIN,1/S,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AA1K	DEFAULT	-	MIDSHIP ACCEL DYNAMICS GAIN (1.0)
AA1NT	DEFAULT	SEC	MIDSHIP ACCEL DYNAMICS LEAD TIME CONSTANT (0.0)
AA1TC	DEFAULT	SEC	MIDSHIP ACCEL DYNAMICS LAG TIME CONSTANT (0.0)
AA1W2	DEFAULT	R**2/S**2	MIDSHIP ACCEL DYNAMICS 2ND ORDER LAG

			OMEGA**2 TERM (0.0)
AA1ZW	DEFAULT	R/S	MIDSHIP ACCEL DYNAMICS 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AAF1DY	DEFAULT	-	TRSFR FNCTN FOR MIDSHIP ACCELERATION LOOP FEEDBACK PATH FILTER:1/S,PURE-GAIN, 1-LAG,2-LAG,1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
AAF1K	DEFAULT	-	MIDSHIP ACC FEEDBACK FILTER GAIN (1.0)
AAF1NT	DEFAULT	SEC	MIDSHIP ACC FEEDBACK FILTER LEAD TIME CONSTANT (0.0)
AAF1TC	DEFAULT	SEC	MIDSHIP ACC FEEDBACK FILTER LAG TIME CONSTANT (0.0)
AAF1W2	DEFAULT	R**2/S**2	MIDSHIP ACC FEEDBACK FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AAF1ZW	DEFAULT	R/S	MIDSHIP ACC FEEDBACK FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AGF2DY	DEFAULT	-	TRSFR FNCTN FOR FORWARD-ACCELERATION-LOOP FORWARD-PATH-FILTER:1/S,PURE-GAIN, 1-LAG,2-LAG,1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
AGF2K	DEFAULT	-	FORWARD ACCEL FORWARD FILTER GAIN (1.0)
AGF2NT	DEFAULT	SEC	FORWARD ACCEL FORWARD FILTER LEAD TIME CONSTANT (0.0)
AGF2TC	DEFAULT	SEC	FORWARD ACCEL FORWARD FILTER LAG TIME CONSTANT (0.0)
AGF2W2	DEFAULT	R**2/S**2	FORWARD ACCEL FORWARD FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AGF2ZW	DEFAULT	R/S	FORWARD ACCEL FORWARD FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AA2DY	DEFAULT	-	TRSFR FNCTN FOR FORWARD ACCELEROMETER: 1/S,PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AA2K	DEFAULT	-	FORWARD ACCELEROMETER DYNAMICS GAIN(1.0)
AA2NT	DEFAULT	SEC	FORWARD ACCELEROMETER DYNAMICS LEAD TIME CONSTANT (0.0)
AA2TC	DEFAULT	SEC	FORWARD ACCELEROMETER DYNAMICS LAG TIME CONSTANT (0.0)
AA2W2	DEFAULT	R**2/S**2	FORWARD ACCELEROMETER DYNAMICS 2ND ORDER LAG OMEGA**2 TERM (0.0)
AA2ZW	DEFAULT	R/S	FORWARD ACCELEROMETER DYNAMICS 2ND ORDER LAG OMEGA**2 TERM (0.0)
AAF2DY	DEFAULT	-	TRSFR FNCTN FOR FORWARD-ACCELERATION-LOOP FEEDBACK-PATH-FILTER:1/S,1-LAG, PURE-GAIN,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AAF2K	DEFAULT	-	FWDACC FEEDBACK FILTER GAIN (1.0)
AAF2NT	DEFAULT	SEC	FWDACC FEEDBACK FILTER LEAD TIME CONSTANT (0.0)
AAF2TC	DEFAULT	SEC	FWDACC FEEDBACK FILTER LAG TIME CONSTANT (0.0)
AAF2W2	DEFAULT	R**2/S**2	FWDACC FEEDBACK FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AAF2ZW	DEFAULT	R/S	FWDACC FEEDBACK FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
ATADY	DEFAULT	-	TRSFR FNCTN FOR THRUST VECTOR CONTROL ACTUATOR:1/S,PURE-GAIN,1-LAG,2-LAG, 1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
ATAK	DEFAULT	-	THRUST VECTOR CONTROL GAIN (1.0)
ATANT	DEFAULT	SEC	TVC LEAD TIME CONSTANT (0.0)
ATATC	DEFAULT	SEC	TVC LAG TIME CONSTANT. (0.0)

ATAW2	DEFAULT	R**2/S**2	TVC 2ND ORDER LAG OMEGA**2 TERM (0.0)
ATAZW	DEFAULT	R/S	TVC 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AANFDY	DEFAULT	-	TRSFR FNCTN FOR ANGLE-CONTROL (ALPHA-BETA) FEEDBACK PATH, FIRST FILTER:1/S, PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AANFK	DEFAULT	-	ALPHA-BETA FEEDBACK FILTER GAIN (1.0)
AANFNT	DEFAULT	SEC	ALPHA-BETA FEEDBACK FILTER LEAD TIME CONSTANT (0.0)
AANFTC	DEFAULT	SEC	ALPHA-BETA FEEDBACK FILTER LAG TIME CONSTANT (0.0)
AANFW2	DEFAULT	R**2/S**2	ALPHA-BETA FEEDBACK FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AANFZW	DEFAULT	R/S	ALPHA-BETA FEEDBACK FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
AANGDY	DEFAULT	-	TRSFR FNCTN FOR ANGLE-CONTROL (ALPHA-BETA) FEEDBACK PATH, SECOND FILTER:1/S, PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
AANGK	DEFAULT	-	ALPHA-BETA 2ND FEEDBACK FILTER GAIN(1.0)
AANGNT	DEFAULT	SEC	ALPHA-BETA 2ND FEEDBACK FILTER LEAD TIME CONSTANT (0.0)
AANGTC	DEFAULT	SEC	ALPHA-BETA 2ND FEEDBACK FILTER LAG TIME CONSTANT (0.0)
AANGW2	DEFAULT	R**2/S**2	ALPHA-BETA 2ND FEEDBACK FILTER 2ND ORDER LAG OMEGA**2 TERM (0.0)
AANGZW	DEFAULT	R/S	ALPHA-BETA 2ND FEEDBACK FILTER 2ND ORDER LAG ZETA*OMEGA TERM (0.0)
ARAPK	DEFAULT	-	ROLL ANGLE GAIN IN ROLL AUTOPILOT (1.0)
ARRK	DEFAULT	-	ROLL RATE GAIN IN ROLL AUTOPILOT (1.0)
CINTK	DEFAULT	-	EXTRA PURE INTEGRATOR GAIN THAT CAN BE USED ANYWHERE (1.0)
AINTK	DEFAULT	-	EXTRA PURE INTEGRATOR GAIN THAT CAN BE USED ANYWHERE (0.)
MXTHDG	DEFAULT	DEG	MAXIMUM THRUST VECTOR CONTROL ANGLE OF DEFLECTION (15.0)

SGTBLE.DAT

```
TEST AUTOPT VARIABLE GAIN TABLES IN METRIC ( 09/07/84 )
CONTROLLER GAIN VS DYNPRS(N/M2) (ACVARK)
STAGE 1
DYNPRS 5
9999
     0.          100000.      200000.      300000.      2000000.
     1.          1.           1.           1.           1.
0000
```

SGUID.DAT (1 of 2)

MISSILE GUIDANCE DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TYPGDP	PRONAV	-	PITCH GUIDANCE TYPE: CONST-ALT,CONST-ANG, CONST-G,PRONAV,PURSUIT,PRONAVR, PKLPRONAV,PRE-PROG,UNKNOWN (PRONAV)
TYPGDY	PRONAV	-	YAW GUIDANCE TYPE: CONST-ANG,CONST-G, PRONAV,PURSUIT,PRONAVR,PKLPRONAV, PRE-PROG,UNKNOWN (PRONAV)
TYPGDR	UNKNOWN	-	ROLL GUIDANCE TYPE: UNKNOWN (UNKNOWN)
TINGD	0.4	SEC	TIME TO INITIATE GUIDANCE AFTER LAUNCH (0.0)
MMNTIM	0.4	SEC	SAFE-ARMING TIME,MIN FLIGHT TIME (0.0)
MMXTIM	60.	SEC	MAXIMUM GUIDED FLIGHT TIME (60.0)
GBIASG	DEFAULT	G	MISSILE G-BIAS (1.0)
LOWMSV	100.	M/SEC	MINIMUM ALLOWABLE FLIGHT SPEED (100.0)
LOWMSM	0.	-	MINIMUM ALLOWABLE FLIGHT MACH NUMBER (0.6)
LOWCLV	150.	M/SEC	MINIMUM ALLOWABLE CLOSING SPEED FOR FUZING (100.0)
MDPERM	5.0	M	WARHEAD LETHAL RADIUS (10.0)
GAVMIN	DEFAULT	G	MINIMUM AVAILABLE GS AVAILABLE CUTOFF (0.0)
AVGDLV	0.	M/S	AVERAGE DELTA-VELOCITY FOR OPTIMUM LEAD ANGLE BIAS,0 = NO OPT. (0.0)
LDVFAC	0.	-	VELOCITY MULTIPLIER IN OPTIMUM LEAD ANGLE EQUATION (1.0)
LDZFAC	0.	-	ALTITUDE MULTIPLIER IN OPTIMUM LEAD ANGLE EQUATION (1.0)
GPAK	DEFAULT	-	GAIN ON ALTITUDE GUIDANCE FILTER (0.025)
GPANT	DEFAULT	SEC	LEAD TIME CONSTANT ON ALTITUDE GUIDANCE FILTER (0.0)
GPATC	DEFAULT	SEC	LAG TIME CONSTANT ON ALTITUDE GUIDANCE FILTER (0.0)
GPCRK	DEFAULT	-	GAIN ON CROSSRANGE GUIDANCE FILTER(.025)
GPCRNT	DEFAULT	SEC	LEAD TIME CONSTANT ON CROSSRANGE GUIDANCE FILTER (0.0)
GPCRTC	DEFAULT	SEC	LAG TIME CONSTANT ON CROSSRANGE GUIDANCE FILTER (0.0)
NVCNST	4.	-	NAVIGATION GAIN:4.0=NOMINAL PRONAV, 1.0=NOMINAL PURSUIT (4.0)
GPNDYN	DEFAULT	-	TRSFR FNCTN FOR GUIDANCE FILTER:1/S, PURE-GAIN,1-LAG,2-LAG,1-LEAD-1-LAG, 1-LEAD-2-LAG (PURE-GAIN)
GPNK	DEFAULT	-	GAIN ON GUIDANCE FILTER (1.0)
GPNNT	DEFAULT	SEC	LEAD TIME CONSTANT ON GUIDANCE FILTER (0.0)
GPNTC	DEFAULT	SEC	LAG TIME CONSTANT ON GUIDANCE FILTER (0.0)
GPNW2	DEFAULT	R**2/S**2	OMEGA**2 IF SECOND ORDER GUIDANCE FILTER USED (0.0)
GPNZW	DEFAULT	R/S	ZETA*OMEGA FOR SECOND ORDER GUIDANCE FILTER (0.0)
PTBISD	DEFAULT	DEG	PITCH BIAS FOR BIASED PURSUIT GUIDANCE (0.0)
YWBISD	DEFAULT	DEG	YAW BIAS FOR BIASED PURSUIT GUIDANCE(0.)
G3PK	DEFAULT	-	GAIN ON 3-POINT GUIDANCE FILTER (0.0)
G3PNT	DEFAULT	SEC	LEAD TIME CONSTANT ON 3-POINT GUIDANCE FILTER (0.0)

G3PTC	DEFAULT	SEC	LAG TIME CONSTANT ON 3-POINT GUIDANCE FILTER (0.0)
MAXDST	DEFAULT	M/S**2	MAX GUIDANCE COMMAND FOR LEAD ANGLE GUIDANCE (400000.00)
GLAK	DEFAULT	-	GAIN ON LEAD-ANGLE GUIDANCE FILTER(1.0)
GLANT	DEFAULT	SEC	LEAD TIME CONSTANT ON LEAD-ANGLE GUIDANCE FILTER (0.0)
GLATC	DEFAULT	SEC	LAG TIME CONSTANT ON LEAD-ANGLE GUIDANCE FILTER (0.0)

SMASS.DAT

MISSILE MASS PROPERTIES DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
SYMMET	DEFAULT	-	IF TRUE, MISSILE SYMMETRIC ABOUT XY PLANE (TRUE)
INMSMS	85.28	KG	INITIAL MISSILE MASS (1.0)
INITCG	1.57	M	INITIAL CG,AFT OF NOSE (1.0)
BOMSMS	57.61	KG	BURNOUT MASS (1.0)
BOCG	1.39	M	BURNOUT CG,AFT OF NOSE (1.0)
CGPROP	1.94	M	CG OF THE PROPELLANT (1.0)
ININX	DEFAULT	KG*M**2	INITIAL X ROLL MOMENT OF INERTIA (1.0)
ININY	DEFAULT	KG*M**2	INITIAL Y PITCH MOMENT OF INERTIA (1.0)
ININZ	DEFAULT	KG*M**2	INITIAL Z YAW MOMENT OF INERTIA (1.0)
BOINX	DEFAULT	KG*M**2	BURNOUT X ROLL MOMENT OF INERTIA (1.0)
BOINY	DEFAULT	KG*M**2	BURNOUT Y PITCH MOMENT OF INERTIA (1.0)
BOINZ	DEFAULT	KG*M**2	BURNOUT Z YAW MOMENT OF INERTIA (1.0)
MOFFX	0.0	M	INITIAL MISSILE CG X-OFFSET FROM A/C REF CG, A/C AXES (0.0)
MOFFY	0.0	M	INITIAL MISSILE CG Y-OFFSET FROM A/C REF CG, A/C AXES (0.0)
MOFFZ	0.0	M	INITIAL MISSILE CG Z-OFFSET FROM A/C REF CG, A/C AXES (0.0)

PPTBLE.DAT (GENERIC)

```
TEST VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .1          .15         .25         .3
      .6        1.2         1.75        2.75        3.6
     3.9        4.2          4.4         4.5        4.8
     5.0        5.2          5.4         5.7        6.0
   18865.     17482.       16263.      14514.     13823.
   12563.     11303.       10977.      11181.     11709.
   11994.     11505.       10489.       9188.      5692.
    3659.      2358.        1301.        569.         0.
0000
```

PPTBLE.DAT (All Configuration 1 Variants - 4 tables)

```
MOTOR1A VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .03          .07         2.11         2.31
     2.6         2.74         2.8          2.9          3.9
     4.9         4.93         5.6         7.01          7.4
     7.6          7.7         7.75         7.8         7.88
      0.0        5008.       13604.       13604.       12565.
    9798.        4535.        2007.          0.           0.
       0.        5965.       13604.       13604.       11447.
    7689.        3457.        2720.         591.           0.
0000

MOTOR1B VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .03          .07         2.11         2.31
     2.6         2.74         2.8          2.9          4.9
     6.9         6.93         7.6         9.01          9.4
     9.6          9.7         9.75         9.8         9.88
      0.0        5008.       13604.       13604.       12565.
    9798.        4535.        2007.          0.           0.
       0.        5965.       13604.       13604.       11447.
    7689.        3457.        2720.         591.           0.
0000

MOTOR1C VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .03          .07         2.11         2.31
     2.6         2.74         2.8          2.9          5.9
     7.9         7.93         7.6         10.01         10.4
    10.6         10.7        10.75         10.8        10.88
      0.0        5008.       13604.       13604.       12565.
    9798.        4535.        2007.          0.           0.
       0.        5965.       13604.       13604.       11447.
    7689.        3457.        2720.         591.           0.
0000

MOTOR1D VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .03          .07         2.11         2.31
     2.6         2.74         2.8          2.9          4.9
     8.9         8.93         9.6         11.01         11.4
    11.6         11.7        11.75         11.8         11.88
      0.0        5008.       13604.       13604.       12565.
    9798.        4535.        2007.          0.           0.
       0.        5965.       13604.       13604.       11447.
    7689.        3457.        2720.         591.           0.
0000
```

PPTBLE.DAT (All Configuration 2 Variants - 4 tables)

```
MOTOR2A VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .06          2.53         2.9
    3.01         3.2         3.36          3.47         4.47
    5.47         5.51        6.06          7.33         7.62
    7.77         7.82        7.91          7.98         8.11
     0.0        11776.      13627.        13627.       11705.
   11060.        7384.       2232.            0.           0.
     0.          5989.      12363.        12363.       10881.
    9491.        8061.       4747.         1413.           0.
0000

MOTOR2B VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .06          2.53         2.9
    3.01         3.2         3.36          3.47         5.47
    7.47         7.51        8.06          9.33         9.62
    9.77         9.82        9.91          9.98        10.11
     0.0        11776.      13627.        13627.       11705.
   11060.        7384.       2232.            0.           0.
     0.          5989.      12363.        12363.       10881.
    9491.        8061.       4747.         1413.           0.
0000

MOTOR2C VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .06          2.53         2.9
    3.01         3.2         3.36          3.47         6.47
    8.47         8.51        9.06         10.33        10.62
   10.77        10.82       10.91         10.98        11.11
     0.0        11776.      13627.        13627.       11705.
   11060.        7384.       2232.            0.           0.
     0.          5989.      12363.        12363.       10881.
    9491.        8061.       4747.         1413.           0.
0000

MOTOR2D VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .06          2.53         2.9
    3.01         3.2         3.36          3.47         6.47
    9.47         9.51       10.06         11.33        11.62
   11.77        11.82       11.91         11.98        12.11
     0.0        11776.      13627.        13627.       11705.
   11060.        7384.       2232.            0.           0.
     0.          5989.      12363.        12363.       10881.
    9491.        8061.       4747.         1413.           0.
0000
```

PPTBLE.DAT (All Configuration 3 Variants - 4 tables)

```
MOTOR3A VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .1          2.8          2.96
    3.36          3.5          3.7         3.83          4.83
    5.83          5.85         6.43        7.60          8.02
    6.11          8.19         8.23        8.30          8.46
     0.0         11052.       13721.      13721.        13119.
   10963.         8580.        2619.          0.            0.
       0.         2785.       10561.      10561.         8789.
    7744.         5401.        4747.       1183.            0.
0000

MOTOR3B VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .1          2.8          2.96
    3.36          3.5          3.7         3.83          5.83
    7.83          7.85         8.43        9.60         10.02
   10.11         10.19        10.23       10.30         10.46
     0.0         11052.       13721.      13721.        13119.
   10963.         8580.        2619.          0.            0.
       0.         2785.       10561.      10561.         8789.
    7744.         5401.        4747.       1183.            0.
0000

MOTOR3C VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .1          2.8          2.96
    3.36          3.5          3.7         3.83          6.83
    8.83          8.85         9.43       10.60         11.02
   11.11         11.19        11.23       11.30         11.46
     0.0         11052.       13721.      13721.        13119.
   10963.         8580.        2619.          0.            0.
       0.         2785.       10561.      10561.         8789.
    7744.         5401.        4747.       1183.            0.
0000

MOTOR3D VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .1          2.8          2.96
    3.36          3.5          3.7         3.83          7.83
    9.83          9.85        10.43       11.60         12.02
   12.11         12.19        12.23       12.30         12.46
     0.0         11052.       13721.      13721.        13119.
   10963.         8580.        2619.          0.            0.
       0.         2785.       10561.      10561.         8789.
    7744.         5401.        4747.       1183.            0.
0000
```

PPTBLE.DAT (All Configuration 4 Variants - 4 tables)

```
MOTOR4A VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .09         2.94         3.02
    3.26         3.50         3.85         4.01         5.01
    6.01         6.03          6.6         7.93         8.13
    8.27         8.41         8.53         8.62         8.71
     0.0        10789.       13661.       13661.       13375.
   12152.       10976.        3522.           0.           0.
     0.          2419.        9166.         9166.        8789.
    7765.        6381.        2843.          451.           0.
0000

MOTOR4B VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .09         2.94         3.02
    3.26         3.50         3.85         4.01         5.01
    8.01         8.03          8.6         9.93        10.13
   10.27        10.41        10.53        10.62        10.71
     0.0        10789.       13661.       13661.       13375.
   12152.       10976.        3522.           0.           0.
     0.          2419.        9166.         9166.        8789.
    7765.        6381.        2843.          451.           0.
0000

MOTOR4C VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .09         2.94         3.02
    3.26         3.50         3.85         4.01         7.01
    9.01         9.03          9.6        10.93        11.13
   11.27        11.41        11.53        11.62        11.71
     0.0        10789.       13661.       13661.       13375.
   12152.       10976.        3522.           0.           0.
     0.          2419.        9166.         9166.        8789.
    7765.        6381.        2843.          451.           0.
0000

MOTOR4D VACUUM TABLE
VACUUM THRUST(N) VS TIME(SEC)
STAGE 1
TIME 20
9999
     0.          .01          .09         2.94         3.02
    3.26         3.50         3.85         4.01         7.01
   10.01        10.03         10.6        11.93        12.13
   12.27        12.41        12.53        12.62        12.71
     0.0        10789.       13661.       13661.       13375.
   12152.       10976.        3522.           0.           0.
     0.          2419.        9166.         9166.        8789.
    7765.        6381.        2843.          451.           0.
0000
```

SPROP.DAT

MISSILE PROPULSION DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TYPTHR	VAC-VS-T	-	PROPULSION TYPE:CON-VAC,VAC-VS-T,TURBO, AXIAL-ACCEL,CON-VAC-TURBO (VAC-VS-T)
EXAREA	0.0113	M**2	MOTOR EXIT AREA (0.0)
VACISP	2450.0	---->	(UNITS=KG-M/SEC**2) VACUUM SPECIFIC IMPULSE (1.0)
VACTHR	0.	N	SOLID ROCKET VACUUM DELIVERED THRUST(1.)
TIGN1	0.	SEC	BOOSTER IGNITION TIME,AFTER LAUNCH (0.0)
TB1	6.0	SEC	BOOSTER BURNTIME (9999.0)
TIGN2	0.	SEC	SUSTAINER IGNITION TIME,AFTER LAUNCH(0.)
TB2	0.	SEC	SUSTAINER BURNTIME (9999.0)
THROTL	1.	-	THRUST AND FLOWRATE THROTTLE FACTOR APPLIED TO ALL TYPTHRS (1.0)
CONOP	DEFAULT	-	AIR BREATHER THROTTLE SETTING,0=THROTTLE TO CRMACH (0.0)
KDELT	DEFAULT	-	CURVE FIT FACTOR ON DELTA MACH FOR ATTAINING CRUISE (4.0)
KRATE	DEFAULT	-	CURVE FIT FACTOR ON MACH RATE FOR ATTAINING CRUISE (2.0)
CRMACH	DEFAULT	-	AIR BREATHER MACH TO CRUISE AT (1.5)
SCLFAC	DEFAULT	MS2/C	AXIAL-ACCEL MULTIPLICATIVE FACTOR ON ACCELERATION DATA (1.0)
ZERPT	DEFAULT	COUNTS	AXIAL-ACCEL BIAS ON ACCELERATION (0.0)
LONTVC	0.0	M	TVC MOMENT ARM IN PITCH AND YAW (0.0)
LATTVC	0.0	M	TVC MOMENT ARM IN ROLL (0.0)

SSEEK.DAT (1 of 4)

MISSILE SEEKER DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TYPSEK	IR	-	SEEKER TO MODEL:GENERIC,IR,RADAR (GENERIC)
INTSKR	DEFAULT	-	INITIAL ANTENNA POSITION:LOS-ALIGNED, USER-DEFINED,BORESIGHTED (LOS-ALIGNED)
GIMTYP	DEFAULT	-	GIMBAL CONFIGURATION: INNER-PITCH, INNER-YAW (INNER-PITCH)
GIMROL	DEFAULT	-	GIMBAL ORIENTATION: PLUS-CONFIG, X-CONFIG (PLUS-CONFIG)
SKRFLG	PERFECT-FILT	-	SEEKER SIMULATION TYPE:PERFECT, PERFECT-FILT,REAL-SEEKER (PERFECT)
PLATFL	DEFAULT	-	SEEKER PLATFORM STABILIZATION TYPE: RATE, MOMENTUM (MOMENTUM)
PLTFRM	DEFAULT	-	SEEKER PLATFORM MECHANIZATION TYPE: INERT-HOLD,ATT-FEEDBACK,LOS-RATE, UNKNOWN (LOS-RATE)
BRKACT	DEFAULT	-	SEEKER BEHAVIOR WHEN LOCK IS LOST: ZERO-OUTPUT, HOLD-OUTPUT (HOLD-OUTPUT)
SEKGAD	60.	DEG	GIMBAL ANGLE LIMIT (60.0)
SEKGRD	20.	DEG/S	GIMBAL ANGULAR RATE LIMIT (15.0)
LSRLMD	20.	DEG/S	LINE-OF-SIGHT TRACKING RATE LIMIT (15.0)
ZFVLMD	6.	DEG	VERTICAL HALF-ANGLE FOV LIMIT (10.0)
YFVLMD	6.	DEG	HORIZONTAL HALF-ANGLE FOV LIMIT (10.0)
RAQUIR	100000.	M	MAX SEEKER ACQUISITION RANGE (1000000.00
RLCKON	100000.	M	MAX SEEKER LOCKON RANGE (1000000.00)
LDELAY	0.1	SEC	DELAY FROM ACQUISITION TO LOCKON (0.0)
SNRREQ	1.5	-	SIGNAL-TO-NOISE RATIO REQUIRED TO TRACK (1.0)
NEI	DEFAULT	W/SR	NOISE EQUIVALENT INTENSITY FOR IR SEEKER (.0000005)
LAMLOW	3.9	UM	LOWER LIMIT ON WAVELENGTH SPECTRUM FOR IR SEEKER (3.5)
LAMUP	4.5	UM	UPPER LIMIT ON WAVELENGTH SPECTRUM FOR IR SEEKER (5.4)
PWFDYN	1-LAG	-	TRSFR FNCTN FOR FILTER ON LOS RATES FOR PERFECT-FILT SKR:PURE-GAIN,1-LAG,2-LAG, 1/S,1-LEAD-1-LAG,1-LEAD-2-LAG(PURE-GAIN)
PWFK	10.	-	GAIN ON SEEKER LOS RATE FILTER (1.0)
PWFTC	0.1	SEC	LAG TIME CONSTANT ON SEEKER LOS RATE FILTER (0.01)
PWFNT	DEFAULT	SEC	LEAD TIME CONSTANT ON SEEKER LOS RATE FILTER (0.0)
PWFZW	DEFAULT	R/S	ZETA*OMEGA TERM ON SEEKER LOS RATE FILTER (0.0)
PWFW2	DEFAULT	R**2/S**2	OMEGA**2 TERM ON SEEKER LOS RATE FILTER (0.0)
SPTBSD	DEFAULT	DEG	PITCH GIMBAL ANGLE BIAS (0.0)
SYWBSD	DEFAULT	DEG	YAW GIMBAL ANGLE BIAS (0.0)
SBISYD	DEFAULT	DEG	HORIZONTAL LOOK ANGLE BIAS (0.0)
SBISZD	DEFAULT	DEG	VERTICAL LOOK ANGLE BIAS (0.0)
GAINSK	DEFAULT	R/S/R	LOS RATE GAIN FACTOR (1.0)
SCALE	DEFAULT	-	LOS RATE BIAS FACTOR: (1.+SCALE)*LOSRATE (0.0)
ZDRIFT	DEFAULT	RAD/S	REAL SEEKER VERTICAL DRIFT ERROR (0.0)
YDRIFT	DEFAULT	RAD/S	REAL SEEKER HORIZONTAL DRIFT ERROR(0.0)
PTGAND	DEFAULT	DEG	SEEKER PLATFORM PITCH GIMBAL COMMAND FOR ANGLE HOLD (0.0) .

YWGAND	DEFAULT	DEG	SEEKER PLATFORM YAW GIMBAL COMMAND FOR ANGLE HOLD (0.0)
CCZTOY	DEFAULT	-	REAL SEEKER VERTICAL TO HORIZONTAL CROSS COUPLING ERROR FACTOR (0.0)
CCYTOZ	DEFAULT	-	REAL SEEKER HORIZONTAL TO VERTICAL CROSS COUPLING ERROR FACTOR (0.0)
YCMDLM	DEFAULT	RAD/S	REAL SEEKER HORIZ COMMAND LIMIT (10.0)
ZCMDLM	DEFAULT	RAD/S	REAL SEEKER VERTICAL COMAND LIMIT (10.0)
SGFDYN	DEFAULT	-	TRSFR FNCTN FOR SEEKER GUIDANCE SIGNAL FILTER:PURE-GAIN,1-LAG,2-LAG,1/S, 1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
SGFK	DEFAULT	-	GAIN ON SEEKER GUIDANCE FILTER (1.0)
SGFTC	DEFAULT	SEC	LAG TIME CONSTANT ON SEEKER GUIDANCE FILTER (0.0)
SGFNT	DEFAULT	SEC	LEAD TIME CONSTANT ON SEEKER GUIDANCE FILTER (0.0)
SGFZW	DEFAULT	R/S	ZETA*OMEGA TERM ON SEEKER GUIDANCE FILTER (0.0)
SGFW2	DEFAULT	R**2/S**2	OMEGA**2 TERM ON SEEKER GUIDANCE FILTER (0.0)
PLTDYN	DEFAULT	-	TRSFR FNCTN FOR SEEKER PLATFORM RATE PRECESSION:PURE-GAIN,1-LAG,2-LAG,1/S, 1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
PLTK	DEFAULT	-	GAIN ON SEEKER PLATFORM FILTER (1.0)
PLTTC	DEFAULT	SEC	LAG TIME CONSTANT ON SEEKER PLATFORM FILTER (0.0)
PLTNT	DEFAULT	SEC	LEAD TIME CONSTANT ON SEEKER PLATFORM FILTER (0.0)
PLTZW	DEFAULT	R/S	ZETA*OMEGA TERM ON SEEKER PLATFORM FILTER (0.0)
PLTW2	DEFAULT	R**2/S**2	OMEGA**2 TERM ON SEEKER PLATFORM FILTER (0.0)
AIXO	DEFAULT	KG*M**2	SEEKER OUTER GIMBAL ROLL MOMENT OF INERTIA (0.0)
AIXI	DEFAULT	KG*M**2	SEEKER INNER GIMBAL ROLL MOMENT OF INERTIA (0.0)
AIYO	DEFAULT	KG*M**2	SEEKER OUTER GIMBAL PITCH MOMENT OF INERTIA (0.0)
AIYI	DEFAULT	KG*M**2	SEEKER INNER GIMBAL PITCH MOMENT OF INERTIA (0.0)
AIZO	DEFAULT	KG*M**2	SEEKER OUTER GIMBAL YAW MOMENT OF INERTIA (0.0)
AIZI	DEFAULT	KG*M**2	SEEKER INNER GIMBAL YAW MOMENT OF INERTIA (0.0)
TFRICN	DEFAULT	N/M	FRICTION TORQUE FOR RATE STABILIZED PLATFORM (0.0)
FRICTN	DEFAULT	RAD/S	GIMBAL FRICTION INDUCED DRIFT MOMENTUM STABILIZATION (0.0)
SEKMAS	DEFAULT	KG	MASS OF SEEKER (1.0)
GYRDYN	DEFAULT	-	TRSFR FNCTN FOR SEEKER PLATFORM MOUNTED RATE GYRO:PURE-GAIN,1-LAG,2-LAG,1/S, 1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
GYRK	DEFAULT	-	GAIN ON SEEKER PLATFORM RATE GYRO (1.0)
GYRTC	DEFAULT	SEC	LAG TIME CONSTANT ON SEEKER PLATFORM RATE GYRO (0.0)
GYRNT	DEFAULT	SEC	LEAD TIME CONSTANT ON SEEKER PLATFORM RATE GYRO (0.0)
GYRZW	DEFAULT	R/S	ZETA*OMEGA TERM ON SEEKER PLATFORM RATE GYRO (0.0)
GYRW2	DEFAULT	R**2/S**2	OMEGA**2 TERM ON SEEKER PLATFORM RATE

			GYRO (0.0)
TQFDYN	DEFAULT	-	TRSFR FNCTN FOR SEEKER PLATFORM TORQUE COMMAND:PURE-GAIN,1-LAG,2-LAG,1/S, 1-LEAD-1-LAG,1-LEAD-2-LAG (PURE-GAIN)
TQFK	DEFAULT	-	GAIN ON SEEKER PLATFORM TORQUE COMMAND (1.0)
TQFTC	DEFAULT	SEC	LAG TIME CONSTANT ON SEEKER PLATFORM TORQUE COMMAND (0.0)
TQFNT	DEFAULT	SEC	LEAD TIME CONSTANT ON SEEKER PLATFORM TORQUE COMMAND (0.0)
TQFZW	DEFAULT	R/S	ZETA*OMEGA TERM ON SEEKER PLATFORM TORQUE COMMAND (0.0)
TQFW2	DEFAULT	R**2/S**2	OMEGA**2 TERM ON SEEKER PLATFORM TORQUE COMMAND (0.0)
TQLIMT	DEFAULT	N/M	SEEKER PLATFORM TORQUE LIMIT (20.0)
SINTK	DEFAULT	-	GENERAL PURE INTEGRATOR GAIN (0.0)
ILUMFN	NOT-INPUT	-	TYPE OF ILLUMINATION FUNCTION: SEE DATA DICTIONARY (NOT-INPUT)
ANTDIA	DEFAULT	M	DIAMETER OF SEEKER ANTENNA (0.0)
FREQ	0.	GHZ	ANTENNA OPERATING FREQUENCY (0.0)
RCVRNF	9.	DB	RECEIVER NOISE FIGURE (9.0)
SNGGAN	60.	DB	SINGLE BEAM ON-AXIS GAIN (60.0)
SNGFSL	25.	DB	FIRST SIDELOBE LEVEL DOWN FROM MAINLOBE, EG. -20. (-25.0)
RCVLDB	10.	DB	COMBINED RECEIVER LOSSES (10.0)
POLZRC	LINEAR-VERT	-	RECEIVER POLARIZATION:CIRCULAR-LFT, CIRCULAR-RGT,LINEAR-VERT,LINEAR-HORIZ (LINEAR-VERT)
RCVTYP	SEMI-ACTIVE	-	TYPE OF RADAR RECEIVER:SEMI-ACTIVE, ACTIVE, PASSIVE (SEMI-ACTIVE)
PRFPW	.2	S	PULSE WIDTH (.2)
DOPGAT	1500.	HZ	DOPPLER GATE (BIN) WIDTH, SETS NOISE BANDWIDTH (1500.00)
DOPCEN	0.	HZ	CENTER OF DOPPLER GATE (0.0) (0=USE TRUE TGT DOPPLER)
DOPSHF	NO POLARITY	-	INDICATES POLARITY OF DOPPLER SHIFT: NO POLARITY, POLARITY (NO POLARITY)
DOPLIM	270000.	HZ	MAX CHANGE OF DOPPLER GATE PER PASS (270000.00)
NBIN	21	-	NUMBER OF CLUTTER BINS-NBIN*NBIN (21.0)
ORIENT	SQUARE	-	MONOPULSE BEAM ORIENTATION: SQUARE, PLUS-ORIENT (SQUARE)
PMIN	-110.	DB(W)	FIXED DYNAMIC RANGE MIN (-110.00)
PMAX	0.	DB(W)	FIXED DYNAMIC RANGE MAX (0.0)
DBAGCH	10.	DB	AGC DYNAMIC RANGE ABOVE SETPOINT (10.0)
DBAGCL	10.	DB	AGC DYNAMIC RANGE BELOW SETPOINT (10.0)
DBSHFT	10.	DB	MAX AGC SHIFT PER PASS (10.0)
AGCOPT	DYN-RNG-FIXD	-	AGC OPTION:DYN-RNG-FIXED,ANYTHING (DYN-RNG-FIXD)
CLTOPT	NO-CLUTTER	-	CLUTTER OPTION:NO-CLUTTER,ANYTHING (NO-CLUTTER)
MULOPT	NO-MULT-PATH	-	MULTIPATH OPTION:NO-MULT-PATH,ANYTHING (NO-MULT-PATH)
JAMOPT	NO-JAMMER	-	TYPE OF JAMMER:NO-JAMMER,AIRBORNE, GROUND-BASED (NO-JAMMER)
DOPOPT	NO-DOP-SORT	-	DOPPLER BIN OPTION:NO-DOP-SORT, ANYTHING (NO-DOP-SORT)
DOPDF	100.	HZ	DOPPLER SORT BIN SIZE (100.0)
NDPBIN	100	-	NUMBER OF DOPPLER SORT BINS, 250 MAX (250.00)

DOPLOW	0.	HZ	DOPPLER SHIFT FREQUENCY OF FIRST BIN-USE 0 TO CENTER ON TGT (0.0)
DOPREF	REAR	-	MISSILE REAR REFERENCE ANTENNA: REAR, ANYTHING (REAR)
ANAREA	0.	M**2	ANTENNA PHYSICAL AREA (0.0)
WAVELN	0.	M	ANTENNA WAVELENGTH (0.0)
SNBWTH	0.	DEG	SINGLE CHANNEL 3DB MAINLOBE BEAMWIDTH (10.0)
SUMGAN	0.	DB	SUM CHANNEL MAINBEAM GAIN (1.0)
SMBWTH	0.	DEG	SUM CHANNEL 3DB BEAMWIDTH (10.0)

SCENAR.DAT (1 of 2)

TEST RUN SINGLE SHOT

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
FLYFLG	4	-	1=PERF RECON 2=SINGLE SHOT 3=CONST-G FLY 4=LAR BOUNDARY 5=LAR GRID 6=ALTITUDE RNG (2)
TYPSIM	POINT-MASS	-	POINT-MASS 3-DOF-PITCH 3-DOF-YAW 5-DOF 6-DOF MISSILE (POINT-MASS)
TERRAN	SEA-STATE-1	-	SEE DATA DICTIONARY FOR 9 ALLOWABLE TERRAIN TYPES (SEA-STATE-1)
NEMITR	0	-	NUMBER OF EMITTERS TO MODEL (0)
RCSSWP	CONE-ANGLE	-	PATTERN OF SIGNATURE DATA: GREAT-CIRCLE CONE-ANGLE (CONE-ANGLE)
TYPMSL	GSRAAM	-	MISSILE BEING MODELED-AT FASTC, MISSILE MODULE (GENERIC)
PLTFLG	FALSE	-	IF TRUE, WRITE OUTPUT FOR PLOTTING (FALSE)
DELTAT	0.010	SEC	STEPSIZE/INTEGRATION RATE-RECOMMEND 0.01 (0.01)
LNCHTM	0.000	SEC	MISSILE LAUNCH TIME AFTER SIMULATION START TIME (0.0)
MINTIM	2.000	SEC	MINIMUM SIMULATION TIME-COULD BE SAFE ARMING TIME (0.0)
MAXTIM	60.000	SEC	MAXIMUM SIMULATION TIME AND TERMINATION CRITERION (60.0)
TYPAC	CF18	-	FIGHTER TO MODEL, E.G. GENERIC, FLANKER, FULCRUM (GENERIC)
TYPRAD	GENERIC	-	FIGHTER RADAR TO MODEL, E.G. GENERIC, HIGHLARK (NONE)
INACPX	10000.000	M	INITIAL SHOOTER DOWNRANGE POSITION (0.0)
INACPY	0.000	M	INITIAL SHOOTER CROSSRANGE POSITION(0.0)
INACPZ	5000.000	M	INITIAL SHOOTER ALTITUDE (10000.0)
INACVL	290.000	M/S	INITIAL SHOOTER VELOCITY (299.50)
INACMC	0.000	-	INITIAL SHOOTER MACH NUMBER, =0 IF INACVL INPUT (1.0)
INTHAC	0.000	DEG	INITIAL SHOOTER PITCH ATTITUDE,+ = CLIMB (0.0)
INPSAC	0.000	DEG	INITIAL SHOOTER YAW ATTITUDE,- = LEFT TURN (0.0)
INPHAC	0.000	DEG	INITIAL SHOOTER ROLL ANGLE (0.0)
AIM	TRUE	-	IF TRUE, CAUSES SHOOTER TO AIM AT TARGET (TRUE)
LEADH	0.000	DEG	FIXED YAW LEAD ANGLE ON AIM=TRUE (0.0)
LEADV	0.000	DEG	FIXED PITCH LEAD ANGLE ON AIM=TRUE (0.0)
AMANVR	NONE	-	SHOOTER MANEUVER: NONE,PRSUIT,OFFSET, CONALT,CONSTG,LVLTRN (NONE)
ACGP	0.000	G	SHOOTER VERTICAL GS TO PULL IN MANEUVER (0.0)
ACGY	0.000	G	SHOOTER HORIZONTAL GS TO PULL IN MANEUVER (0.0)
PSICAD	180.0	DEG	HEADING TO WHICH SHOOTER SHOULD MANEUVER SET ELSEWHERE (180.0)
FFSTAD	45.0	DEG	AIRCRAFT OFFSET MANEUVER HEADING CHANGE (45.0)
TGTFLG	TRUE	-	IF TRUE, THE MISSILE IS FIRED AT A TARGET (TRUE)
TYPTGT	MIG29	-	TARGET TO MODEL, E.G. GENERIC, F-15 (GENERIC)

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INTGPX          0.000 M         INITIAL TARGET DOWNRANGE POSITION(10000)
INTGPY          0.000 M         INITIAL TARGET CROSSRANGE POSITION (0.0)
INTGPZ       5000.000 M         INITIAL TARGET ALTITUDE (10000.0)
INTGVL        290.000 M/S       INITIAL TARGET VELOCITY  (299.5)
INTGMC          0.000 -         INITIAL TARGET MACH NUMBER, =0 IF
                                INTGVL INPUT  (1.0)
INTHTG          0.000 DEG       INITIAL TARGET PITCH ATTITUDE, +=
                                CLIMB   (0.0)
INPSTG          0.000 DEG       INITIAL TARGET YAW ATTITUDE, - =LEFT
                                TURN    (0.0)
INPHTG          0.000 DEG       INITIAL TARGET ROLL ANGLE (0.0)
TMANVR           NONE -         TARGET MANEUVER: NONE,PRSUIT,OFFSET,
                                CONALT,CONSTG,LVLTRN,STURN,LDRAG,
                                DDRAG,LBEAM,SLICE (NONE)
TGTGP         1.0000 G          TARGET VERTICAL GS TO PULL IN MANEUVER
                                (1.0)
TGTGY         0.0000 G          TARGET HOPIZONTAL GS TO PULL IN
                                MANEUVER (0.0)
DLTAMC           0.2 M          MACH INCREMENT IN DESCENT OF DDRAG(0.2)
FFSTND           0.0 DEG        TARGET OFFSET MANEUVER HEADING CHANGE
                                (45.0)
LVLALT        5000.  M          ALTITUDE AT WHICH TARGET LEVELS OFF
                                AFTER DIVE (500.0)
SAFALT         500.  M          SAFE ALTITUDE AT WHICH TARGET ENDS MAX
                                G PULLOUT, DDRAG (500.0)
PSICMD         180.  DEG        HEADING ANGLE TO WHICH TARGET SHOULD
                                MANEUVER (180.0)
TGCRM1           2.3 -          TARGET SHOULD ACCELERATE TO THIS MACH,
                                DRAG, AND ACCELERATE  (1.5)
TGCRM2           2.3 -          MACH NUMBER USED TO SET THROTTLE TO
                                ACHIEVE DESIRED MACH NUMBER (2.0)
TMAINT           1.5 SEC        TIME TO HOLD BETWEEN TURNS IN STURN
                                MANEUVER (3.0)
TGTSIG       400.000 --->       SINGLE VALUE FOR TARGET SIGNATURE
                                (UNITS=M**2 OR W/CM**2) (10.)
PLANE              XY -         LAUNCH ZONES ARE GENERATED IN XY OR
                                XZ PLANES (XY)
NOSTGT             1 -          NUMBER OF TARGET AIRCRAFT,MAX IS 2 (1)
XOFF          -500.0 M          TARGET 2 HORIZONTAL PLANE X-OFFSET FROM
                                TARGET 1, W.R.T. PSIVTG  (-500.0)
YOFF           500.0 M          TARGET 2 HORIZONTAL PLANE Y-OFFSET FROM
                                TARGET 1, W.R.T. PSIVTG  (500.0)
ZOFF             0.0 M          TARGET 2 VERTICAL PLANE Z-OFFSET FROM
                                TARGET 1  POSITIVE DOWN  (0.0)
MTDLAY           0.0 SEC        TIME TO INITIATE TARGET MANEUVER (0.0)
END CASE
```

LARBND.DAT

LAUNCH ZONE (BY BOUNDARY) CONTROL DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
IOBFLG	O	-	RANGE BOUNDARY TO FIND:I=INNER,O=OUTER, B=BOTH INNER AND OUTER (B)
MINASA	90.	DEG	STARTING ASPECT ANGLE,0.=TAIL,180.=NOSE (0.0)
MAXASA	95	DEG	LAST ASPECT ANGLE,90 IF FULL QTR (90.0)
DELASA	5.	DEG	DELTA ASPECT ANGLE,E.G.+10 FROM MINASA TO MAXASA (10.0)
MINDTA	DEFAULT	DEG	MIN ANGLE RESOLUTION, USUALLY 1 DEG (1.0)
MINRNG	1456.	M	MINIMUM LAUNCH RANGE, IF 0, PROGRAM USES MINTIM (1000.0)
MAXRNG	12050.	M	MAXIMUM RANGE SOLUTION, SEARCH STARTS HERE (400000.0)
DTRNGT	50.	M	MINIMUM RANGE RESOLUTION, USUALLY 50-500 (50.0)
SEARCH	BINARY	-	BOUNDARY SEARCH ALGORITHM:SMART,BINARY (SMART)
RFAC	1.0	-	MULTIPLIER ON REPORTED LAUNCH ZONE BOUNDARY VALUE (1.0)

ACTBLE.DAT (1 of 16)

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SAMPLE LAUNCHER TABLE DATA :  AERO AND ENGINE
ALPHA VS CL & MACH
STAGE 1
CL 11
MACH 18
9999
    0.0000000E+000.2000000E+000.4000000E+000.6000000E+000.8000000E+00
    0.1000000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
    0.2000000E+01
    0.4000000E+000.5000000E+000.6000000E+000.7000000E+000.8000000E+00
    0.8500000E+000.9000000E+000.9500000E+000.1000000E+010.1050000E+01
    0.1100000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
    0.2000000E+010.2200000E+010.2400000E+01
    0.0000000E+000.3076922E+010.6153846E+010.9230769E+010.1233333E+02
    0.1581818E+020.1959999E+020.2466664E+020.3139999E+020.3139999E+02
    0.3139999E+02
    0.0000000E+000.2985074E+010.5970148E+010.8955223E+010.1194030E+02
    0.1513043E+020.1888889E+020.2386665E+020.3070000E+020.3070000E+02
    0.3070000E+02
    0.0000000E+000.2898550E+010.5797101E+010.8695652E+010.1159420E+02
    0.1463636E+020.1839998E+020.2333331E+020.2989999E+020.2989999E+02
    0.2989999E+02
    0.0000000E+000.2777778E+010.5555555E+010.8333333E+010.1111111E+02
    0.1400000E+020.1749998E+020.2299997E+020.2830000E+020.2830000E+02
    0.2830000E+02
    0.0000000E+000.2666666E+010.5333333E+010.8000000E+010.1066667E+02
    0.1348148E+020.1722221E+020.2400000E+020.2530000E+020.2530000E+02
    0.2530000E+02
    0.0000000E+000.2614379E+010.5228758E+010.7843137E+010.1048276E+02
    0.1338461E+020.1737498E+020.2350000E+020.2350000E+020.2350000E+02
    0.2350000E+02
    0.0000000E+000.2564102E+010.5128204E+010.7692307E+010.1050000E+02
    0.1352000E+020.1786665E+020.2120000E+020.2120000E+020.2120000E+02
    0.2120000E+02
    0.0000000E+000.2515723E+010.5078946E+010.8000000E+010.1083333E+02
    0.1514286E+020.1850000E+020.1850000E+020.1850000E+020.1850000E+02
    0.1850000E+02
    0.0000000E+000.2469135E+010.4974358E+010.7920000E+010.1220000E+02
    0.1610001E+020.1610001E+020.1610001E+020.1610001E+020.1610001E+02
    0.1610001E+02
    0.0000000E+000.2439024E+010.4888888E+010.7833333E+010.1450000E+02
    0.1450000E+020.1450000E+020.1450000E+020.1450000E+020.1450000E+02
    0.1450000E+02
    0.0000000E+000.2409637E+010.4819276E+010.7821428E+010.1260000E+02
    0.1260000E+020.1260000E+020.1260000E+020.1260000E+020.1260000E+02
    0.1260000E+02
    0.0000000E+000.2409637E+010.4860759E+010.8000000E+010.1050000E+02
    0.1050000E+020.1050000E+020.1050000E+020.1050000E+020.1050000E+02
    0.1050000E+02
    0.0000000E+000.2777778E+010.5555555E+010.8800000E+010.8800000E+01
    0.8800000E+010.8800000E+010.8800000E+010.8800000E+010.8800000E+01
    0.8800000E+01
    0.0000000E+000.3278687E+010.6557376E+010.8200000E+010.8200000E+01
    0.8200000E+010.8200000E+010.8200000E+010.8200000E+010.8200000E+01
    0.8200000E+01
    0.0000000E+000.3773584E+010.7547169E+010.8300000E+010.8300000E+01
    0.8300000E+010.8300000E+010.8300000E+010.8300000E+010.8300000E+01
    0.8300000E+01
    0.0000000E+000.4255318E+010.8510000E+010.8510000E+010.8510000E+01
    0.8510000E+010.8510000E+010.8510000E+010.8510000E+010.8510000E+01
```

```
    0.8510000E+01
    0.0000000E+000.4761905E+010.8810000E+010.8810000E+010.8810000E+01
    0.8810000E+010.8810000E+010.8810000E+010.8810000E+010.8810000E+01
    0.8810000E+01
    0.0000000E+000.5263157E+010.9470000E+010.9470000E+010.9470000E+01
    0.9470000E+010.9470000E+010.9470000E+010.9470000E+010.9470000E+01
    0.9470000E+01
0000
CLMAX VS MACH
STAGE 1
MACH 22
9999
    0.0000000E+000.2000000E+000.3000000E+000.4000000E+000.5000000E+00
    0.6000000E+000.7000000E+000.8000000E+000.9000000E+000.1000000E+01
    0.1100000E+010.1200000E+010.1300000E+010.1400000E+010.1500000E+01
    0.1600000E+010.1700000E+010.1800000E+010.2000000E+010.2200000E+01
    0.2500000E+010.3000000E+01
    0.1520000E+010.1520000E+010.1520000E+010.1520000E+010.1520000E+01
    0.1510000E+010.1470000E+010.1410000E+010.1270000E+010.8600000E+00
    0.7400000E+000.6600000E+000.6100000E+000.5700000E+000.5300000E+00
    0.5000000E+000.4700000E+000.4400000E+000.4000000E+000.3700000E+00
    0.3500000E+000.3200000E+00
0000
CD VS CL & MACH
STAGE 1
CL 17
MACH 19
9999
    0.0000000E+000.1000000E+000.2000000E+000.3000000E+000.4000000E+00
    0.5000000E+000.6000000E+000.7000000E+000.8000000E+000.9000000E+00
    0.1000000E+010.1100000E+010.1200000E+010.1300000E+010.1400000E+01
    0.1500000E+010.1600000E+01
    0.4000000E+000.6000000E+000.8000000E+000.8400000E+000.8800000E+00
    0.9200000E+000.9600000E+000.1000000E+010.1040000E+010.1080000E+01
    0.1120000E+010.1160000E+010.1200000E+010.1400000E+010.1600000E+01
    0.1800000E+010.2000000E+010.2200000E+010.2400000E+01
    0.2080000E-010.2220000E-010.2630000E-010.3320000E-010.4340000E-01
    0.5840000E-010.9130001E-010.1393000E+000.2035000E+000.2848000E+00
    0.3836000E+000.5021000E+000.6403000E+000.7990000E+000.9817000E+00
    0.1187800E+010.1417800E+01
    0.2050000E-010.2180000E-010.2590000E-010.3280000E-010.4320000E-01
    0.5790000E-010.8870000E-010.1353000E+000.1983000E+000.2776000E+00
    0.3743000E+000.4888000E+000.6215000E+000.7748000E+000.9486000E+00
    0.1144800E+010.1363800E+01
    0.2030000E-010.2160000E-010.2560000E-010.3230000E-010.4230000E-01
    0.5800000E-010.8389997E-010.1321000E+000.1972000E+000.2788000E+00
    0.3782000E+000.4961000E+000.6328000E+000.7884000E+000.9643000E+00
    0.1160800E+010.1380800E+01
    0.2070000E-010.2200000E-010.2590000E-010.3260000E-010.4290000E-01
    0.5930000E-010.8569998E-010.1320000E+000.1962000E+000.2755000E+00
    0.3768000E+000.4980000E+000.6377000E+000.7897000E+000.9714000E+00
    0.1169800E+010.1389800E+01
    0.2360000E-010.2490000E-010.2880000E-010.3550000E-010.4650000E-01
    0.6430000E-010.9079999E-010.1365000E+000.1984000E+000.2767000E+00
    0.3765000E+000.4968000E+000.6332000E+000.7850000E+000.9600000E+00
    0.1148800E+010.1381800E+01
    0.3020000E-010.3150000E-010.3550000E-010.4250000E-010.5420000E-01
    0.7309997E-010.1006000E+000.1431000E+000.2029000E+000.2806000E+00
    0.3787000E+000.5013000E+000.6374000E+000.7830000E+000.9399000E+00
    0.1147200E+010.1371200E+01
```

```
    0.3770000E-010.3900000E-010.4310000E-010.5060000E-010.6339997E-01
    0.8279997E-010.1112000E+000.1522000E+000.2104000E+000.2872000E+00
    0.3829000E+000.5068000E+000.6375000E+000.7790000E+000.9374000E+00
    0.1132200E+010.1365200E+01
    0.4420000E-010.4550000E-010.4970000E-010.5790000E-010.7109994E-01
    0.9099996E-010.1197000E+000.1597999E+000.2175999E+000.2937000E+00
    0.3839999E+000.5049999E+000.6342000E+000.7825999E+000.9406000E+00
    0.1123099E+010.1354099E+01
    0.4710000E-010.4840000E-010.5270000E-010.6120000E-010.7509995E-01
    0.9599996E-010.1249999E+000.1643000E+000.2204999E+000.2940000E+00
    0.3857999E+000.5017999E+000.6346999E+000.7826999E+000.9402000E+00
    0.1122499E+010.1340500E+01
    0.4880000E-010.5010000E-010.5460000E-010.6359994E-010.7779998E-01
    0.9880000E-010.1282000E+000.1665000E+000.2222000E+000.2930000E+00
    0.3798000E+000.4891000E+000.6217000E+000.7643000E+000.9219000E+00
    0.1112700E+010.1324699E+01
    0.5020000E-010.5160000E-010.5610000E-010.6569999E-010.8059996E-01
    0.1013000E+000.1300000E+000.1696000E+000.2229000E+000.2926000E+00
    0.3757000E+000.4781000E+000.5937000E+000.7312000E+000.8800000E+00
    0.1048699E+010.1251699E+01
    0.5080000E-010.5230000E-010.5690000E-010.6680000E-010.8169997E-01
    0.1021000E+000.1314000E+000.1701000E+000.2227000E+000.2916000E+00
    0.3742000E+000.4734000E+000.5862000E+000.7180000E+000.8634000E+00
    0.2690000E-010.1216600E+01
    0.5140000E-010.5290000E-010.5760000E-010.6779999E-010.8269995E-01
    0.1028000E+000.1328000E+000.1705999E+000.2225000E+000.2905999E+00
    0.3726000E+000.4686999E+000.5786999E+000.7046999E+000.8468000E+00
    0.1004999E+010.1180500E+01
    0.5060000E-010.5320000E-010.6090000E-010.7359999E-010.9139997E-01
    0.1145000E+000.1428000E+000.1761000E+000.2144000E+000.2578999E+00
    0.3067000E+000.3606000E+000.4194000E+000.4832000E+000.5519000E+00
    0.6259000E+000.7052000E+00
    0.4980000E-010.5290000E-010.6230000E-010.7789999E-010.9979999E-01
    0.1279000E+000.1622000E+000.2028000E+000.2496000E+000.3025000E+00
    0.3614000E+000.4268000E+000.4986000E+000.5763000E+000.6600000E+00
    0.7497000E+000.8453000E+00
    0.4900000E-010.5270000E-010.6379998E-010.8219999E-010.1082000E+00
    0.1414000E+000.1817000E+000.2297000E+000.2851000E+000.3477000E+00
    0.4174000E+000.4945000E+000.5788000E+000.6702000E+000.7683000E+00
    0.8679000E+000.9664000E+00
    0.4840000E-010.5260000E-010.6539994E-010.8659995E-010.1163999E+00
    0.1547999E+000.2017000E+000.2567999E+000.3202000E+000.3921999E+00
    0.4726999E+000.5612000E+000.6576000E+000.7574000E+000.8558000E+00
    0.9542000E+000.1052800E+01
    0.4780000E-010.5260000E-010.6699997E-010.9099996E-010.1245999E+00
    0.1679000E+000.2207000E+000.2825999E+000.3541999E+000.4352999E+00
    0.5254999E+000.6244000E+000.7226999E+000.8209999E+000.9193000E+00
    0.1017699E+010.1115700E+01
    0.4720000E-010.5250000E-010.6849992E-010.9529996E-010.1327000E+00
    0.1804000E+000.2387000E+000.3076000E+000.3871999E+000.4768999E+00
    0.5745999E+000.6719000E+000.7692000E+000.8665000E+000.9636999E+00
    0.1060699E+010.1157700E+01
0000
THRUST(N) VS MACH & ALTITUDE(M) & POWER SETTING
STAGE 1
MACH 13
ALTITUDE 13
THROTL  9
9999
    0.4000000E+000.6000000E+000.7000000E+000.8000000E+000.9000000E+00
```

0.1000000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
0.2000000E+010.2200000E+010.2400000E+01
0.0000000E+000.2999841E+040.5999984E+040.8999828E+040.1099993E+05
0.1199967E+050.1399977E+050.1599986E+050.1799966E+050.1999975E+05
0.2199985E+050.2399964E+050.2599974E+05
0.1000000E+010.2000000E+010.3000000E+010.4000000E+010.5000000E+01
0.6000000E+010.7000000E+010.8000000E+010.9000000E+01
0.4781598E+040.2935680E+040.9919038E+03-.9741118E+03-.8798141E+04
-.1247219E+05-.1657770E+05-.3293744E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3318208E+040.2019392E+040.6894399E+03-.6938879E+03-.6160477E+04
-.8669148E+04-.1154701E+05-.2281379E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1365536E+040.4581438E+03-.4714878E+03-.4141086E+04-.5871359E+04
-.7824031E+04-.1548348E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.8940479E+030.3113599E+03-.2846719E+03-.2704384E+04-.3825280E+04
-.5084062E+04-.1007472E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7872959E+030.1401120E+040.2846719E+03-.2535360E+03-.1378880E+04
-.6000352E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6716479E+030.1196512E+040.2446400E+03-.2179520E+03-.1178720E+04
-.5128543E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4892798E+030.8718079E+030.1779200E+03-.1601280E+03-.8584639E+03
-.3740768E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3558398E+030.6360640E+030.1289920E+03-.1156480E+03-.6271680E+03
-.2726624E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2624319E+030.4625918E+030.9340799E+02-.8451199E+02-.4581438E+03
-.1988256E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1912640E+030.3380479E+030.6671999E+02-.6227199E+02-.3335999E+03
-.1450048E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1378880E+030.2490880E+030.4892799E+02-.4448000E+02-.2446400E+03
-.1058624E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1023040E+030.1823680E+030.3558400E+02-.3113599E+02-.1779200E+03
-.7739519E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7116800E+020.1289920E+030.2668799E+02-.2223999E+02-.1289920E+03
-.5559998E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1764966E+050.1489635E+050.1252112E+050.1104438E+050.5217504E+04
0.1316608E+04-.3460544E+04-.1090205E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1384662E+050.1195177E+050.1099101E+050.9945727E+040.6307262E+04
0.3816384E+040.4625918E+03-.5181918E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.9634367E+040.9305215E+040.8669148E+040.6382879E+040.4768254E+04
0.2651008E+04-.9251838E+030.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7899645E+040.7695039E+040.7227996E+040.5880254E+040.4888352E+04
0.3620672E+040.1365536E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6623070E+040.6302812E+040.5439902E+040.4710430E+040.3758560E+04
0.2179520E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00

0.0000000E+000.0000000E+000.0000000E+00
0.5657855E+040.5386527E+040.4648156E+040.4025440E+040.3211456E+04
0.1863712E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4127742E+040.3927584E+040.3389376E+040.2935680E+040.2344096E+04
0.1356640E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3011296E+040.2864512E+040.2473088E+040.2143936E+040.1708032E+04
0.9919038E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2197312E+040.2090560E+040.1805888E+040.1561248E+040.1245440E+04
0.7205759E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1601280E+040.1525664E+040.1316608E+040.1138688E+040.9073918E+03
0.5293118E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1169824E+040.1112000E+040.9607678E+030.8317759E+030.6627520E+03
0.3825278E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.8540159E+030.8095359E+030.6983359E+030.6049280E+030.4848318E+03
0.2802239E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6138240E+030.5826880E+030.5026238E+030.4359038E+030.3469438E+03
0.2001600E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2234675E+050.1989145E+050.1930432E+050.1791654E+050.1293923E+05
0.9434207E+040.4892797E+04-.2864512E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1808112E+050.1678230E+050.1630637E+050.1522105E+050.1220531E+05
0.9892352E+040.6907742E+040.1730272E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1376211E+050.1346854E+050.1281024E+050.1093763E+050.9443102E+04
0.7468191E+040.4274527E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1094653E+050.1082643E+050.1041277E+050.9376383E+040.8477887E+04
0.7308062E+040.5261980E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.9220703E+040.8864863E+040.8219902E+040.7623871E+040.6827680E+04
0.5413215E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7877406E+040.7574941E+040.7023391E+040.6511871E+040.5831324E+04
0.4625918E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.5746812E+040.5524414E+040.5124094E+040.4750461E+040.4256734E+04
0.3371584E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4194461E+040.4029888E+040.3736320E+040.3464992E+040.3104704E+04
0.2459744E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3055776E+040.2940128E+040.2726624E+040.2526464E+040.2264032E+04
0.1796992E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2232896E+040.2143936E+040.1988256E+040.1845920E+040.1650208E+04
0.1307712E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1627968E+040.1565696E+040.1450048E+040.1347744E+040.1205408E+04
0.9563198E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1187616E+040.1143136E+040.1058624E+040.9830078E+030.8807039E+03
0.6983359E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00

0.0000000E+000.0000000E+000.0000000E+00
0.8540159E+030.8228799E+030.7606079E+030.7072319E+030.6316160E+03
0.5026238E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2989056E+050.2801795E+050.2751532E+050.2606973E+050.2188861E+05
0.1848144E+050.1442041E+050.7281375E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2430387E+050.2309846E+050.2273817E+050.2175516E+050.1930877E+05
0.1720931E+050.1439818E+050.9576543E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1871718E+050.1837913E+050.1777865E+050.1639088E+050.1506982E+05
0.1342406E+050.1047504E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1498976E+050.1488301E+050.1435814E+050.1349968E+050.1269014E+05
0.1173382E+050.9941277E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1261453E+050.1225424E+050.1176941E+050.1124899E+050.1047948E+05
0.9247391E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1077750E+050.1047059E+050.1005693E+050.9612125E+040.8953820E+04
0.7899645E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7859613E+040.7637215E+040.7334750E+040.7010047E+040.6529660E+04
0.5764605E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.5737918E+040.5573344E+040.5350941E+040.5115199E+040.4763805E+04
0.4203359E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.3064672E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3051328E+040.2966816E+040.2846720E+040.2722176E+040.2535360E+04
0.2237344E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.1623520E+040.1579040E+040.1516768E+040.1450048E+040.1347744E+04
0.1192064E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1169824E+040.1138688E+040.1089760E+040.1045280E+040.9741118E+03
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.1407347E+050.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.1202294E+050.0000000E+000.0000000E+000.0000000E+000.0000000E+00

0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.6400672E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.5155230E+040.5346492E+040.5288672E+040.5190812E+040.4995102E+04
0.4665949E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.3407168E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.2486432E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2001600E+040.2077216E+040.2054976E+040.2014944E+040.1939328E+04
0.1810336E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.1307712E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.4355926E+050.4051238E+050.3500131E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.3081574E+050.3202115E+050.3254157E+050.3185212E+050.3114045E+05
0.2989056E+050.2796457E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2062093E+050.2189305E+050.2343206E+050.2380570E+050.2435280E+05
0.2446845E+050.2345875E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1605283E+050.1734720E+050.1815673E+050.1910416E+050.1957564E+05
0.2005603E+050.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1371318E+050.1482073E+050.1551018E+050.1631971E+050.1672448E+05
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0.0000000E+000.0000000E+000.0000000E+00
0.1000355E+050.1080864E+050.1131571E+050.1190729E+050.1220086E+05
0.1249888E+050.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7299164E+040.7886301E+040.8255484E+040.8686941E+040.8900445E+04
0.9118398E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.5324254E+040.5751262E+040.6022590E+040.6333949E+040.6489629E+04
0.6649758E+040.0000000E+000 J000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3883104E+040.4198910E+040.4394621E+040.4621469E+040.4737117E+04
0.4852766E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2833376E+040.3060224E+040.3207008E+040.3371584E+040.3456096E+04
0.3540608E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2068320E+040.2232896E+040.2339648E+040.2459744E+040.2522016E+04
0.2584288E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1490080E+040.1610176E+040.1685792E+040.1770304E+040.1814784E+04
0.1859264E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00

0.0000000E+000.0000000E+000.0000000E+00
0.6469616E+050.6306819E+050.6324611E+050.6198732E+050.6013251E+05
0.5817984E+050.5537315E+050.5025795E+050.2978825E+050.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4758470E+050.4685078E+050.4860329E+050.5049814E+050.4969750E+05
0.4871005E+050.4706429E+050.4408857E+050.3472998E+050.3064672E+05
0.0000000E+000.0000000E+000.0000000E+00
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0.3889331E+050.3743437E+050.3221241E+050.3240812E+050.2900541E+05
0.2119027E+050.0000000E+000.0000000E+00
0.2062093E+050.2189305E+050.2368115E+050.2479760E+050.2632326E+05
0.2775552E+050.2845830E+050.2814694E+050.2915219E+050.2996173E+05
0.2906768E+050.2298726E+050.1226313E+05
0.1605283E+050.1734720E+050.1815673E+050.1929542E+050.2049193E+05
0.2173737E+050.2351657E+050.2629212E+050.2747974E+050.2910326E+05
0.3068230E+050.2555821E+050.1746729E+05
0.1371318E+050.1482073E+050.1551018E+050.1648429E+050.1750732E+05
0.1857040E+050.2009161E+050.2246240E+050.2347654E+050.2486432E+05
0.2621206E+050.2183523E+050.1492304E+05
0.1000355E+050.1080864E+050.1131571E+050.1202294E+050.1277021E+05
0.1354416E+050.1465616E+050.1638643E+050.1712480E+050.1813449E+05
0.1912195E+050.1592829E+050.1088425E+05
0.7299164E+040.7886301E+040.8255484E+040.8775902E+040.9318559E+04
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0.7210207E+040.7797344E+040.8718078E+040.9113949E+040.9652156E+04
0.1017702E+050.8473437E+040.5791293E+04
0.3883104E+040.4198910E+040.4394621E+040.4670398E+040.4959520E+04
0.5261980E+040.5688988E+040.6360637E+040.6649758E+040.7041184E+04
0.7423711E+040.6182719E+040.4225598E+04
0.2833376E+040.3060224E+040.3207008E+040.3407168E+040.3616224E+04
0.3838624E+040.4149980E+040.4639262E+040.4852766E+040.5137437E+04
0.5417660E+040.4510270E+040.3082464E+04
0.2068320E+040.2232896E+040.2339648E+040.2486432E+040.2637664E+04
0.2797792E+040.3029088E+040.3384928E+040.3540608E+040.3749664E+04
0.3949824E+040.3291520E+040.2250688E+04
0.1490080E+040.1610176E+040.1685792E+040.1788096E+040.1899296E+04
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0.2846720E+040.2370784E+040.1619072E+04
0.6898844E+050.6752506E+050.6793875E+050.6738275E+050.6567469E+05
0.6365088E+050.6107993E+050.5640954E+050.3556621E+050.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.5062713E+050.5007113E+050.5211277E+050.5461699E+050.5399427E+05
0.5316694E+050.5224621E+050.4965747E+050.4040563E+050.3700736E+05
0.0000000E+000.0000000E+000.0000000E+00
0.3429853E+050.3658035E+050.3945821E+050.4061913E+050.4218483E+05
0.4335465E+050.4240723E+050.3737654E+050.3823500E+050.3598432E+05
0.3123830E+050.0000000E+000.0000000E+00
0.2227558E+050.2377456E+050.2591405E+050.2752422E+050.2922780E+05
0.3109152E+050.3242592E+050.3280845E+050.3464547E+050.3645580E+05
0.3698957E+050.3334221E+050.2579840E+05
0.1743616E+050.1902409E+050.2010941E+050.2153277E+050.2310736E+05
0.2497552E+050.2751532E+050.3146515E+050.3342672E+050.3654477E+05
0.3991190E+050.3715414E+050.3097142E+05
0.1489635E+050.1625299E+050.1718262E+050.1839693E+050.1974022E+05
0.2133705E+050.2350768E+050.2688371E+050.2856061E+050.3122051E+05
0.3409837E+050.3174093E+050.2646115E+05
0.1086646E+050.1185392E+050.1253002E+050.1341961E+050.1439818E+05
0.1556355E+050.1714704E+050.1960678E+050.2082998E+050.2277376E+05

```
     0.2487321E+050.2315184E+050.1929987E+05
     0.7926332E+040.8651359E+040.9145086E+040.9790047E+040.1050618E+05
     0.1135574E+050.1251222E+050.1430921E+050.1519881E+050.1661773E+05
     0.1814784E+050.1689350E+050.1408237E+05
     0.5782398E+040.6307262E+040.6667551E+040.7139039E+040.7663902E+04
     0.8282176E+040.9122848E+040.1043501E+050.1108441E+050.1212080E+05
     0.1323725E+050.1232096E+050.1027043E+05
     0.4221148E+040.4603680E+040.4866109E+040.5208605E+040.5591133E+04
     0.6044828E+040.6658652E+040.7614973E+040.8086461E+040.8842621E+04
     0.9656605E+040.8989406E+040.7494879E+04
     0.3078016E+040.3358240E+040.3549504E+040.3803040E+040.4078816E+04
     0.4407965E+040.4857215E+040.5555551E+040.5902492E+040.6449598E+04
     0.7045629E+040.6556352E+040.5466590E+04
     0.2246240E+040.2450848E+040.2588736E+040.2771104E+040.2975712E+04
     0.3215904E+040.3545056E+040.4052128E+040.4305660E+040.4705980E+04
     0.5137437E+040.4786047E+040.3989856E+04
     0.1619072E+040.1765856E+040.1863712E+040.1997152E+040.2143936E+04
     0.2317408E+040.2553152E+040.2917888E+040.3100256E+040.3389376E+04
     0.3700736E+040.3447200E+040.2873408E+04
     0.1017124E+060.1045991E+060.1110087E+060.1165954E+060.1191574E+06
     0.1221287E+060.1250421E+060.1269592E+060.1212213E+060.0000000E+00
     0.0000000E+000.0000000E+000.0000000E+00
     0.7488650E+050.7794225E+050.8548162E+050.9381275E+050.9655712E+05
     0.9974637E+050.1031046E+060.1061248E+060.1089404E+060.1194332E+06
     0.0000000E+000.0000000E+000.0000000E+00
     0.5356726E+050.6102211E+050.6852144E+050.7243119E+050.7713719E+05
     0.8207444E+050.8552169E+050.9078362E+050.1025130E+060.1126322E+06
     0.1215504E+060.0000000E+000.0000000E+00
     0.3463657E+050.3989856E+050.4680630E+050.5017789E+050.5438570E+05
     0.5899382E+050.6375318E+050.7190187E+050.8259931E+050.9389281E+05
     0.1053597E+060.1119650E+060.1142736E+06
     0.2873408E+050.3394269E+050.3816384E+050.4144201E+050.4520947E+05
     0.4967081E+050.5839334E+050.6937987E+050.8000169E+050.9159762E+05
     0.1050039E+060.1113022E+060.1134907E+06
     0.2454851E+050.2900096E+050.3260384E+050.3540608E+050.3862643E+05
     0.4243837E+050.4988877E+050.5927405E+050.6835237E+050.7825806E+05
     0.8971169E+050.9509375E+050.9696194E+05
     0.1790764E+050.2115024E+050.2378345E+050.2582509E+050.2817363E+05
     0.3095363E+050.3638909E+050.4323456E+050.4985318E+050.5708118E+05
     0.6543452E+050.6936206E+050.7072319E+05
     0.1306377E+050.1543456E+050.1735164E+050.1884618E+050.2055865E+05
     0.2258694E+050.2655011E+050.3154966E+050.3637574E+050.4165107E+05
     0.4774483E+050.5060934E+050.5160570E+05
     0.9527613E+040.1125789E+050.1265456E+050.1374432E+050.1499421E+05
     0.1647094E+050.1936659E+050.2300950E+050.2653232E+050.3037539E+05
     0.3482339E+050.3690950E+050.3763453E+05
     0.6952223E+040.8215453E+040.9234047E+040.1003024E+050.1093763E+05
     0.1201849E+050.1413129E+050.1678675E+050.1935770E+050.2216438E+05
     0.2540697E+050.2693264E+050.2746195E+05
     0.5070719E+040.5991453E+040.6738719E+040.7316957E+040.7979711E+04
     0.8767008E+040.1030602E+050.1224534E+050.1412240E+050.1616848E+05
     0.1853481E+050.1964681E+050.2003379E+05
     0.3700736E+040.4372383E+040.4915039E+040.5337598E+040.5822430E+04
     0.6396223E+040.7517117E+040.8936031E+040.1030157E+050.1179609E+05
     0.1352192E+050.1433145E+050.1461612E+05
     0.2664352E+040.3149184E+040.3540608E+040.3843072E+040.4194461E+04
     0.4608125E+040.5417660E+040.6436254E+040.7423711E+040.8495680E+04
     0.9741117E+040.1032380E+050.1052841E+05
0000
FUELFL(KG/S) VS MACH & ALTITUDE(M) & POWER SETTING
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STAGE 1
MACH 13
ALTITUDE 13
THROTL  9
9999
    0.4000000E+000.6000000E+000.7000000E+000.8000000E+000.9000000E+00
    0.1000000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
    0.2000000E+010.2200000E+010.2400000E+01
    0.0000000E+000.2999841E+040.5999984E+040.8999828E+040.1099993E+05
    0.1199967E+050.1399977E+050.1599986E+050.1799966E+050.1999975E+05
    0.2199985E+050.2399964E+050.2599974E+05
    0.1000000E+010.2000000E+010.3000000E+010.4000000E+010.5000000E+01
    0.6000000E+010.7000000E+010.8000000E+010.9000000E+01
    0.1838327E+000.1834547E+000.1918967E+000.2300743E+000.2617002E+00
    0.3042879E+000.3713194E+000.4130251E+000.0000000E+000.0000000E+00
    0.0000000E+000.0000000E+000.0000000E+00
    0.1277631E+000.1266291E+000.1324250E+000.1549789E+000.1732488E+00
    0.2022285E+000.2459503E+000.2751821E+000.0000000E+000.0000000E+00
    0.0000000E+000.0000000E+000.0000000E+00
    0.8605736E-010.8895534E-010.1043272E+000.1168012E+000.1329290E+00
    0.1597669E+000.1762727E+000.0000000E+000.0000000E+000.0000000E+00
    0.0000000E+000.0000000E+000.0000000E+00
    0.5682562E-010.5921960E-010.6917351E-010.7660741E-010.8719134E-01
    0.1045792E+000.1149112E+000.0000000E+000.0000000E+000.0000000E+00
    0.0000000E+000.0000000E+000.0000000E+00
    0.5569162E-010.8504933E-010.9538132E-010.1062172E+000.1133991E+00
    0.1057132E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
    0.0000000E+000.0000000E+000.0000000E+00
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0.7620428E+000.9423476E+000.1100602E+010.1231010E+010.1410434E+01
0.1568184E+010.1620600E+010.1609008E+01
0.2987440E+000.3521676E+000.3908493E+000.4350750E+000.4884986E+00
0.5557823E+000.6873254E+000.8027405E+000.8978699E+000.1028783E+01
0.1143819E+010.1182123E+010.1173681E+01
0.2179785E+000.2569122E+000.2851360E+000.3175178E+000.3564515E+00
0.4055912E+000.5016025E+000.5857700E+000.6551955E+000.7507029E+00
0.8346184E+000.8625902E+000.8564162E+00
0.1590109E+000.1873607E+000.2078986E+000.2315864E+000.2599362E+00
0.2958459E+000.3657755E+000.4271371E+000.4777887E+000.5474663E+00
0.6087018E+000.6291137E+000.6245778E+00
0.1160452E+000.1367090E+000.1517029E+000.1689648E+000.1897547E+00
0.2158365E+000.2668661E+000.3117219E+000.3486395E+000.3994173E+00
0.4441470E+000.4590149E+000.4557389E+00
0.8467138E-010.9979129E-010.1107532E+000.1232271E+000.1383470E+00
0.1574989E+000.1946686E+000.2274284E+000.2543922E+000.2914360E+00
0.3240698E+000.3349057E+000.3323857E+00
0.6173958E-010.7282746E-010.8076543E-010.8996338E-010.1009253E+00
0.1149112E+000.1420010E+000.1659408E+000.1854707E+000.2125605E+00
0.2363743E+000.2443123E+000.2425483E+00
0.4447770E-010.5241564E-010.5821161E-010.6476355E-010.7270145E-01
0.8278143E-010.1023113E+000.1194471E+000.1336851E+000.1530889E+00
0.1702248E+000.1760207E+000.1747608E+00
0.5907469E+010.6404536E+010.6995725E+010.7429666E+010.7812199E+01
0.8256093E+010.8745475E+010.9233091E+010.1021916E+020.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4161121E+010.4693845E+010.5291207E+010.5857196E+010.6171816E+01
0.6522094E+010.6933103E+010.7380021E+010.8240343E+010.9258290E+01
0.0000000E+000.0000000E+000.0000000E+00
0.3116714E+010.3731842E+010.4247178E+010.4512280E+010.4813796E+01
0.5175666E+010.5554168E+010.6439942E+010.7402197E+010.8232910E+01
0.9372698E+010.0000000E+000.0000000E+00
0.1928794E+010.2337283E+010.2899365E+010.3107515E+010.3357750E+01
0.3651707E+010.3966201E+010.4643446E+010.5495830E+010.6386392E+01
0.7344238E+010.7990740E+010.8749380E+01
0.1619719E+010.2032618E+010.2399023E+010.2558287E+010.2789242E+01
0.3055983E+010.3648808E+010.4338529E+010.5260715E+010.6009906E+01
0.7101312E+010.7863481E+010.8286081E+01
0.1383847E+010.1736646E+010.2049627E+010.2185706E+010.2383021E+01
0.2610953E+010.3117344E+010.3706642E+010.4494514E+010.5134590E+01
0.6067110E+010.6718274E+010.7079262E+01
0.1009378E+010.1266668E+010.1494979E+010.1594266E+010.1738157E+01
0.1904350E+010.2273780E+010.2703689E+010.3278371E+010.3745198E+01
0.4425342E+010.4900231E+010.5163696E+01
0.7364650E+000.9242038E+000.1090900E+010.1163223E+010.1268307E+01
0.1389044E+010.1659155E+010.1972768E+010.2392093E+010.2732795E+01
0.3228979E+010.3575603E+010.3767752E+01
0.5371343E+000.6740955E+000.7955586E+000.8483523E+000.9249598E+00
0.1013411E+010.1209970E+010.1438783E+010.1744583E+010.1993054E+01
0.2354923E+010.2607677E+010.2747788E+01
0.3919833E+000.4919006E+000.5804780E+000.6190338E+000.6749774E+00
0.7394890E+000.8828760E+000.1049825E+010.1272968E+010.1454281E+01
0.1718375E+010.1902838E+010.2005023E+01
0.2858920E+000.3588455E+000.4234831E+000.4515809E+000.4924046E+00
0.5394023E+000.6441076E+000.7658228E+000.9286137E+000.1060912E+01
0.1253565E+010.1388005E+010.1462597E+01
0.2085285E+000.2617002E+000.3089499E+000.3294877E+000.3592235E+00
0.3934953E+000.4698503E+000.5586802E+000.6773714E+000.7738867E+00

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    0.9143758E+000.1012528E+010.1066960E+01
    0.1503170E+000.1886206E+000.2225144E+000.2373824E+000.2588022E+00
    0.2834980E+000.3385597E+000.4024413E+000.4879947E+000.5575462E+00
    0.6588495E+000.7295350E+000.7687208E+00
0000
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SACFT.DAT

LAUNCH AIRCRAFT SINGLE PARAMETER DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
S	65.	M**2	LAUNCH AIRCRAFT PLANFORM AREA (65.0)
MXMACH	2.4	M	MAXIMUM MACH NUMBER (2.4)
GLIMIT	9.0	G	-LIMIT (9.0)
FIXWT	12000.0	KG	DRY WEIGHT, NO WEAPONS (27,000)
FUELWT	4400.0	KG	FUEL WEIGHT (10,000)
PAYWT	650.0	KG	PAYLOAD, WEAPONS WEIGHT (1,200)
ENG	2.	-	NUMBER OF ENGINES (2)
ACDOT	0.1	M/S**2	MAX CHANGE IN NORMAL ACCELERATION IN ONE TIME STEP (0.1)
PSSAD	180.0	DEG/S	STEADY STATE ROLL RATE (0.0)
TAURA	0.2	SEC	BANK ACCELERATION COMMAND TIME CONSTANT (0.2)
ALTGMN	1.0	G	MIN G TO ACHIEVE DESIRED ALTITUDE (1.0)
ALTGMX	9.0	G	MAX G TO ACHIEVE DESIRED ALTITUDE (9.0)
VLIMTA	50.0	M/S	LIMIT OF ASCENT/DESCENT RATE ALLOWED IN CALCULATING THE COMMANDED NORMAL ACCELERATION TO ACHIEVE THE DESIRED ALTITUDE FOR THE LAUNCH A/C (50.0)
MXWPDD	172.0	DEG/SEC**2	MAXIMUM ROLL ACCELERATION FOR PURSUIT MANEUVER (172.0)
MXGACG	9.0	G	MAX LIFT ACCELERATION FOR PURSUIT MANEUVER (9.0)
MNGACG	0.0	G	MIN LIFT ACCELERATION FOR PURSUIT MANEUVER (0.0)
RDES	500.0	M	DESIRED RANGE BETWEEN TARGET AND LAUNCH A/C IN PURSUIT MANEUVER (500.0)
RFAR	5000.0	M	RANGE RATE>RRDES ALLOWED IF RANGE>RFAR IN PURSUIT MANEUVER (5000.0)
RLINER	1500.0	M	RANGE RATE DECREASES FROM RRDES TO 0 IF RANGE>RLINER (1500.0)
RRDES	-50.0	M/S	DESIRED RANGE RATE FOR RANGE>RLINER & RANGE<RFAR (-50.0)
TIMCNS	5.0	SEC	TIME CONST FOR REACHING TO AZIMUTH & ELEVATION ERRORS FOR LAUNCH A/C IN PURSUIT MANEUVER (25.0)
DTCON	0.2	SEC	TIME CONSTANT FOR ROLL COMMANDS IN PURSUIT MANEUVER (0.2)
MACHCN	20.0	-	CONST FOR MACH CONTROL FOR PURSUIT MANUEVER (20.0)
ACMNAL	500.0	M	MINIMUM ALTITUDE TO CHECK FOR GROUND CLOBBER (500.0)

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SAMPLE TARGET TABLE DATA : RCS, AERO, AND ENGINE
RCS(M 2) VERT LINEAR POLRZTN VS FREQ(GHZ) & ELV(DEG) & AZ(DEG)
STAGE 1
FREQ  5
ELV   3
AZ    3
9999
    0.3000000E+010.5000000E+010.7000000E+010.8500000E+010.1000000E+02
    -.9000000E+020.0000000E+000.9000000E+02
    -.1800000E+030.0000000E+000.1800000E+03
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
0000
RCS(M 2) HORZ LINEAR POLRZTN VS FREQ(GHZ) & ELV(DEG) & AZ(DEG)
STAGE 1
FREQ  5
ELV   3
AZ    3
9999
    0.3000000E+010.5000000E+010.7000000E+010.8500000E+010.1000000E+02
    -.9000000E+020.0000000E+000.9000000E+02
    -.1800000E+030.0000000E+000.1800000E+03
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
0000
RCS(M 2) CIRCULAR POLRZTN VS FREQ(GHZ) & ELV(DEG) & AZ(DEG)
STAGE 1
FREQ  5
ELV   3
AZ    3
9999
    0.3000000E+010.5000000E+010.7000000E+010.8500000E+010.1000000E+02
    -.9000000E+020.0000000E+000.9000000E+02
    -.1800000E+030.0000000E+000.1800000E+03
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
    0.1000000E+020.1000000E+020.1000000E+020.1000000E+020.1000000E+02
0000
ALPHA VS CL & MACH
STAGE 1
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```
CL 11
MACH 18
9999
     0.0000000E+000.2000000E+000.4000000E+000.6000000E+000.8000000E+00
     0.1000000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
     0.2000000E+01
     0.4000000E+000.5000000E+000.6000000E+000.7000000E+000.8000000E+00
     0.8500000E+000.9000000E+000.9500000E+000.1000000E+010.1050000E+01
     0.1100000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
     0.2000000E+010.2200000E+010.2400000E+01
     0.0000000E+000.3076922E+010.6153846E+010.9230769E+010.1233333E+02
     0.1581818E+020.1959999E+020.2466664E+020.3139999E+020.3139999E+02
     0.3139999E+02
     0.0000000E+000.2985074E+010.5970148E+010.8955223E+010.1194030E+02
     0.1513043E+020.1888889E+020.2386665E+020.3070000E+020.3070000E+02
     0.3070000E+02
     0.0000000E+000.2898550E+010.5797101E+010.8695652E+010.1159420E+02
     0.1463636E+020.1839998E+020.2333331E+020.2989999E+020.2989999E+02
     0.2989999E+02
     0.0000000E+000.2777778E+010.5555555E+010.8333333E+010.1111111E+02
     0.1400000E+020.1749998E+020.2299997E+020.2830000E+020.2830000E+02
     0.2830000E+02
     0.0000000E+000.2666666E+010.5333333E+010.8000000E+010.1066667E+02
     0.1348148E+020.1722221E+020.2400000E+020.2530000E+020.2530000E+02
     0.2530000E+02
     0.0000000E+000.2614379E+010.5228758E+010.7843137E+010.1048276E+02
     0.1338461E+020.1737498E+020.2350000E+020.2350000E+020.2350000E+02
     0.2350000E+02
     0.0000000E+000.2564102E+010.5128204E+010.7692307E+010.1050000E+02
     0.1352000E+020.1786665E+020.2120000E+020.2120000E+020.2120000E+02
     0.2120000E+02
     0.0000000E+000.2515723E+010.5078946E+010.8000000E+010.1083333E+02
     0.1514286E+020.1850000E+020.1850000E+020.1850000E+020.1850000E+02
     0.1850000E+02
     0.0000000E+000.2469135E+010.4974358E+010.7920000E+010.1220000E+02
     0.1610001E+020.1610001E+020.1610001E+020.1610001E+020.1610001E+02
     0.1610001E+02
     0.0000000E+000.2439024E+010.4888888E+010.7833333E+010.1450000E+02
     0.1450000E+020.1450000E+020.1450000E+020.1450000E+020.1450000E+02
     0.1450000E+02
     0.0000000E+000.2409637E+010.4819276E+010.7821428E+010.1260000E+02
     0.1260000E+020.1260000E+020.1260000E+020.1260000E+020.1260000E+02
     0.1260000E+02
     0.0000000E+000.2409637E+010.4860759E+010.8000000E+010.1050000E+02
     0.1050000E+020.1050000E+020.1050000E+020.1050000E+020.1050000E+02
     0.1050000E+02
     0.0000000E+000.2777778E+010.5555555E+010.8800000E+010.8800000E+01
     0.8800000E+010.8800000E+010.8800000E+010.8800000E+010.8800000E+01
     0.8800000E+01
     0.0000000E+000.3278687E+010.6557376E+010.8200000E+010.8200000E+01
     0.8200000E+010.8200000E+010.8200000E+010.8200000E+010.8200000E+01
     0.8200000E+01
     0.0000000E+000.3773584E+010.7547169E+010.8300000E+010.8300000E+01
     0.8300000E+010.8300000E+010.8300000E+010.8300000E+010.8300000E+01
     0.8300000E+01
     0.0000000E+000.4255318E+010.8510000E+010.8510000E+010.8510000E+01
     0.8510000E+010.8510000E+010.8510000E+010.8510000E+010.8510000E+01
     0.8510000E+01
     0.0000000E+000.4761905E+010.8810000E+010.8810000E+010.8810000E+01
     0.8810000E+010.8810000E+010.8810000E+010.8810000E+010.8810000E+01
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    0.8810000E+01
    0.0000000E+000.5263157E+010.9470000E+010.9470000E+010.9470000E+01
    0.9470000E+010.9470000E+010.9470000E+010.9470000E+010.9470000E+01
    0.9470000E+01
0000
CLMAX VS MACH
STAGE 1
MACH 22
9999
    0.0000000E+000.2000000E+000.3000000E+000.4000000E+000.5000000E+00
    0.6000000E+000.7000000E+000.8000000E+000.9000000E+000.1000000E+01
    0.1100000E+010.1200000E+010.1300000E+010.1400000E+010.1500000E+01
    0.1600000E+010.1700000E+010.1800000E+010.2000000E+010.2200000E+01
    0.2500000E+010.3000000E+01
    0.1520000E+010.1520000E+010.1520000E+010.1520000E+010.1520000E+01
    0.1510000E+010.1470000E+010.1410000E+010.1270000E+010.8600000E+00
    0.7400000E+000.6600000E+000.6100000E+000.5700000E+000.5300000E+00
    0.5000000E+000.4700000E+000.4400000E+000.4000000E+000.3700000E+00
    0.3500000E+000.3200000E+00
0000
CD VS CL & MACH
STAGE 1
CL 17
MACH 19
9999
    0.0000000E+000.1000000E+000.2000000E+000.3000000E+000.4000000E+00
    0.5000000E+000.6000000E+000.7000000E+000.8000000E+000.9000000E+00
    0.1000000E+010.1100000E+010.1200000E+010.1300000E+010.1400000E+01
    0.1500000E+010.1600000E+01
    0.4000000E+000.6000000E+000.8000000E+000.8400000E+000.8800000E+00
    0.9200000E+000.9600000E+000.1000000E+010.1040000E+010.1080000E+01
    0.1120000E+010.1160000E+010.1200000E+010.1400000E+010.1600000E+01
    0.1800000E+010.2000000E+010.2200000E+010.2400000E+01
    0.2080000E-010.2220000E-010.2630000E-010.3320000E-010.4340000E-01
    0.5840000E-010.9130001E-010.1393000E+000.2035000E+000.2848000E+00
    0.3836000E+000.5021000E+000.6403000E+000.7990000E+000.9817000E+00
    0.1187800E+010.1417800E+01
    0.2050000E-010.2180000E-010.2590000E-010.3280000E-010.4320000E-01
    0.5790000E-010.8870000E-010.1353000E+000.1983000E+000.2776000E+00
    0.3743000E+000.4888000E+000.6215000E+000.7748000E+000.9486000E+00
    0.1144800E+010.1363800E+01
    0.2030000E-010.2160000E-010.2560000E-010.3230000E-010.4230000E-01
    0.5800000E-010.8389997E-010.1321000E+000.1972000E+000.2788000E+00
    0.3782000E+000.4961000E+000.6328000E+000.7884000E+000.9643000E+00
    0.1160800E+010.1380800E+01
    0.2070000E-010.2200000E-010.2590000E-010.3260000E-010.4290000E-01
    0.5930000E-010.8569998E-010.1320000E+000.1962000E+000.2755000E+00
    0.3768000E+000.4980000E+000.6377000E+000.7897000E+000.9714000E+00
    0.1169800E+010.1389800E+01
    0.2360000E-010.2490000E-010.2880000E-010.3550000E-010.4650000E-01
    0.6430000E-010.9079999E-010.1365000E+000.1984000E+000.2767000E+00
    0.3765000E+000.4968000E+000.6332000E+000.7850000E+000.9600000E+00
    0.1148800E+010.1381800E+01
    0.3020000E-010.3150000E-010.3550000E-010.4250000E-010.5420000E-01
    0.7309997E-010.1006000E+000.1431000E+000.2029000E+000.2806000E+00
    0.3787000E+000.5013000E+000.6374000E+000.7830000E+000.9399000E+00
    0.1147200E+010.1371200E+01
    0.3770000E-010.3900000E-010.4310000E-010.5060000E-010.6339997E-01
    0.8279997E-010.1112000E+000.1522000E+000.2104000E+000.2872000E+00
    0.3829000E+000.5068000E+000.6375000E+000.7790000E+000.9374000E+00
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     0.1132200E+010.1365200E+01
     0.4420000E-010.4550000E-010.4970000E-010.5790000E-010.7109994E-01
     0.9099996E-010.1197000E+000.1597999E+000.2175999E+000.2937000E+00
     0.3839999E+000.5049999E+000.6342000E+000.7825999E+000.9406000E+00
     0.1123099E+010.1354099E+01
     0.4710000E-010.4840000E-010.5270000E-010.6120000E-010.7509995E-01
     0.9599996E-010.1249999E+000.1643000E+000.2204999E+000.2940000E+00
     0.3857999E+000.5017999E+000.6346999E+000.7826999E+000.9402000E+00
     0.1122499E+010.1340500E+01
     0.4880000E-010.5010000E-010.5460000E-010.6359994E-010.7779998E-01
     0.9880000E-010.1282000E+000.1665000E+000.2222000E+000.2930000E+00
     0.3798000E+000.4891000E+000.6217000E+000.7643000E+000.9219000E+00
     0.1112700E+010.1324699E+01
     0.5020000E-010.5160000E-010.5610000E-010.6569999E-010.8059996E-01
     0.1013000E+000.1300000E+000.1696000E+000.2229000E+000.2926000E+00
     0.3757000E+000.4781000E+000.5937000E+000.7312000E+000.8800000E+00
     0.1048699E+010.1251699E+01
     0.5080000E-010.5230000E-010.5690000E-010.6680000E-010.8169997E-01
     0.1021000E+000.1314000E+000.1701000E+000.2227000E+000.2916000E+00
     0.3742000E+000.4734000E+000.5862000E+000.7180000E+000.8634000E+00
     0.2690000E-010.1216600E+01
     0.5140000E-010.5290000E-010.5760000E-010.6779999E-010.8269995E-01
     0.1028000E+000.1328000E+000.1705999E+000.2225000E+000.2905999E+00
     0.3726000E+000.4686999E+000.5786999E+000.7046999E+000.8468000E+00
     0.1004999E+010.1180500E+01
     0.5060000E-010.5320000E-010.6090000E-010.7359999E-010.9139997E-01
     0.1145000E+000.1428000E+000.1761000E+000.2144000E+000.2578999E+00
     0.3067000E+000.3606000E+000.4194000E+000.4832000E+000.5519000E+00
     0.6259000E+000.7052000E+00
     0.4980000E-010.5290000E-010.6230000E-010.7789999E-010.9979999E-01
     0.1279000E+000.1622000E+000.2028000E+000.2496000E+000.3025000E+00
     0.3614000E+000.4268000E+000.4986000E+000.5763000E+000.6600000E+00
     0.7497000E+000.8453000E+00
     0.4900000E-010.5270000E-010.6379998E-010.8219999E-010.1082000E+00
     0.1414000E+000.1817000E+000.2297000E+000.2851000E+000.3477000E+00
     0.4174000E+000.4945000E+000.5788000E+000.6702000E+000.7683000E+00
     0.8679000E+000.9664000E+00
     0.4840000E-010.5260000E-010.6539994E-010.8659995E-010.1163999E+00
     0.1547999E+000.2017000E+000.2567999E+000.3202000E+000.3921999E+00
     0.4726999E+000.5612000E+000.6576000E+000.7574000E+000.8558000E+00
     0.9542000E+000.1052800E+01
     0.4780000E-010.5260000E-010.6699997E-010.9099996E-010.1245999E+00
     0.1679000E+000.2207000E+000.2825999E+000.3541999E+000.4352999E+00
     0.5254999E+000.6244000E+000.7226999E+000.8209999E+000.9193000E+00
     0.1017699E+010.1115700E+01
     0.4720000E-010.5250000E-010.6849992E-010.9529996E-010.1327000E+00
     0.1804000E+000.2387000E+000.3076000E+000.3871999E+000.4768999E+00
     0.5745999E+000.6719000E+000.7692000E+000.8665000E+000.9636999E+00
     0.1060699E+010.1157700E+01
0000
THRUST(N) VS MACH & ALTITUDE(M) & POWER SETTING
STAGE 1
MACH 13
ALTITUDE 13
THROTL  9
9999
     0.4000000E+000.6000000E+000.7000000E+000.8000000E+000.9000000E+00
     0.1000000E+010.1200000E+010.1400000E+010.1600000E+010.1800000E+01
     0.2000000E+010.2200000E+010.2400000E+01
     0.0000000E+000.2999841E+040.5999984E+040.8999828E+040.1099993E+05
```

0.1199967E+050.1399977E+050.1599986E+050.1799966E+050.1999975E+05
0.2199985E+050.2399964E+050.2599974E+05
0.1000000E+010.2000000E+010.3000000E+010.4000000E+010.5000000E+01
0.6000000E+010.7000000E+010.8000000E+010.9000000E+01
0.4781598E+040.2935680E+040.9919038E+03-.9741118E+03-.8798141E+04
-.1247219E+05-.1657770E+05-.3293744E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3318208E+040.2019392E+040.6894399E+03-.6938879E+03-.6160477E+04
-.8669148E+04-.1154701E+05-.2281379E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1365536E+040.4581438E+03-.4714878E+03-.4141086E+04-.5871359E+04
-.7824031E+04-.1548348E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.8940479E+030.3113599E+03-.2846719E+03-.2704384E+04-.3825280E+04
-.5084062E+04-.1007472E+050.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7872959E+030.1401120E+040.2846719E+03-.2535360E+03-.1378880E+04
-.6000352E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6716479E+030.1196512E+040.2446400E+03-.2179520E+03-.1178720E+04
-.5128543E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4892798E+030.8718079E+030.1779200E+03-.1601280E+03-.8584639E+03
-.3740768E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.3558398E+030.6360640E+030.1289920E+03-.1156480E+03-.6271680E+03
-.2726624E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2624319E+030.4625918E+030.9340799E+02-.8451199E+02-.4581438E+03
-.1988256E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1912640E+030.3380479E+030.6671999E+02-.6227199E+02-.3335999E+03
-.1450048E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1378880E+030.2490880E+030.4892799E+02-.4448000E+02-.2446400E+03
-.1058624E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1023040E+030.1823680E+030.3558400E+02-.3113599E+02-.1779200E+03
-.7739519E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.7116800E+020.1289920E+030.2668799E+02-.2223999E+02-.1289920E+03
-.5559998E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1764966E+050.1489635E+050.1252112E+050.1104438E+050.5217504E+04
0.1316608E+04-.3460544E+04-.1090205E+050.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1384602E+050.1195177E+050.1099101E+050.9945727E+040.6307262E+04
0.3816384E+040.4625918E+03-.5181918E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.9634367E+040.9305215E+040.8669148E+040.6382879E+040.4768254E+04
0.2651008E+04-.9251838E+030.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.3620672E+040.1365536E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6623070E+040.6302812E+040.5439902E+040.4710430E+040.3758560E+04
0.2179520E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.3011296E+040.2864512E+040.2473088E+040.2143936E+040.1708032E+04
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0.0000000E+000.0000000E+000.0000000E+00
0.2197312E+040.2090560E+040.1805888E+040.1561248E+040.1245440E+04
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.2001600E+030.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2234675E+050.1989145E+050.1930432E+050.1791654E+050.1293923E+05
0.9434207E+040.4892797E+04-.2864512E+040.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1808112E+050.1678230E+050.1630637E+050.1522105E+050.1220531E+05
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0.7308062E+040.5261980E+040.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.4194461E+040.4029888E+040.3736320E+040.3464992E+040.3104704E+04
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0.0000000E+000.0000000E+000.0000000E+00
0.3055776E+040.2940128E+040.2726624E+040.2526464E+040.2264032E+04
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.1859264E+040.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6469616E+050.6306819E+050.6324611E+050.6198732E+050.6013251E+05
0.5817984E+050.5537315E+050.5025795E+050.2978825E+050.0000000E+00

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     0.2873408E+050.3394269E+050.3816384E+050.4144201E+050.4520947E+05
     0.4967081E+050.5839334E+050.6937987E+050.8000169E+050.9159762E+05
     0.1050039E+060.1113022E+060.1134907E+06
     0.2454851E+050.2900096E+050.3260384E+050.3540608E+050.3862643E+05
     0.4243837E+050.4988877E+050.5927405E+050.6835237E+050.7825806E+05
     0.8971169E+050.9509375E+050.9696194E+05
     0.1790764E+050.2115024E+050.2378345E+050.2582509E+050.2817363E+05
     0.3095363E+050.3638909E+050.4323456E+050.4985318E+050.5708118E+05
     0.6543452E+050.6936206E+050.7072319E+05
     0.1306377E+050.1543456E+050.1735164E+050.1884618E+050.2055865E+05
     0.2258694E+050.2655011E+050.3154966E+050.3637574E+050.4165107E+05
     0.4774483E+050.5060934E+050.5160570E+05
     0.9527613E+040.1125789E+050.1265456E+050.1374432E+050.1499421E+05
     0.1647094E+050.1936659E+050.2300950E+050.2653232E+050.3037539E+05
     0.3482339E+050.3690950E+050.3763453E+05
     0.6952223E+040.8215453E+040.9234047E+040.1003024E+050.1093763E+05
     0.1201849E+050.1413129E+050.1678675E+050.1935770E+050.2216438E+05
     0.2540697E+050.2693264E+050.2746195E+05
     0.5070719E+040.5991453E+040.6738719E+040.7316957E+040.7979711E+04
     0.8767008E+040.1030602E+050.1224534E+050.1412240E+050.1616848E+05
     0.1853481E+050.1964681E+050.2003379E+05
     0.3700736E+040.4372383E+040.4915039E+040.5337598E+040.5822430E+04
     0.6396223E+040.7517117E+040.8936031E+040.1030157E+050.1179609E+05
     0.1352192E+050.1433145E+050.1461612E+05
     0.2664352E+040.3149184E+040.3540608E+040.3843072E+040.4194461E+04
     0.4608125E+040.5417660E+040.6436254E+040.7423711E+040.8495680E+04
     0.9741117E+040.1032380E+050.1052841E+05
0000
FUELFL(KG/S) VS MACH & ALTITUDE(M) & POWER SETTING
STAGE 1
MACH 13
ALTITUDE 13
```

0.0000000E+000.0000000E+000.0000000E+00
0.2989960E+000.3366697E+000.3515376E+000.3669095E+000.3825333E+00
0.4005513E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.2181045E+000.2455723E+000.2564082E+000.2676221E+000.2789620E+00
0.2921919E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1591369E+000.1791707E+000.1871087E+000.1952986E+000.2036145E+00
0.2131905E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1160452E+000.1306611E+000.1364570E+000.1423790E+000.1484269E+00
0.1554829E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.8467138E-010.9538132E-010.9953928E-010.1039492E+000.1083592E+00
0.1133991E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.6173958E-010.6955153E-010.7270145E-010.7585144E-010.7900143E-01
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0.0000000E+000.0000000E+000.0000000E+00
0.4510769E-010.5077766E-010.5304564E-010.5531362E-010.5770761E-01
0.6035359E-010.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.1126054E+010.1191699E+010.1296026E+010.1401236E+010.1465999E+01
0.1534165E+010.1630428E+010.1743702E+010.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.1194345E+010.1268054E+010.1337480E+010.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.9694374E+000.1030673E+010.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.4470449E+000.5142025E+000.6018979E+000.6414616E+000.6899713E+00
0.7435210E+000.7800607E+000.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
0.2273024E+000.2688822E+000.2974840E+000.3301177E+000.3593495E+00
0.3970233E+000.0000000E+000.0000000E+000 0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
0.1658148E+000.1961806E+000.2169704E+000.2409104E+000.2622042E+00
0.2896720E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.1123912E+000.0000000E+000.0000000E+000.0000000E+000.0000000E+00
0.0000000E+000.0000000E+000.0000000E+00
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0.0000000E+000.0000000E+000.0000000E+00
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0.1702248E+000.1760207E+000.1747608E+00
0.5907469E+010.6404536E+010.6995725E+010.7429666E+010.7812199E+01
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0.1928794E+010.2337283E+010.2899365E+010.3107515E+010.3357750E+01
0.3651707E+010.3966201E+010.4643446E+010.5495830E+010.6386392E+01
0.7344238E+010.7990740E+010.8749380E+01
0.1619719E+010.2032618E+010.2399023E+010.2558287E+010.2789242E+01
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0.1383847E+010.1736646E+010.2049627E+010.2185706E+010.2383021E+01
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0.4425342E+010.4900231E+010.5163696E+01
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0.1013411E+010.1209970E+010.1438783E+010.1744583E+010.1993054E+01
0.2354923E+010.2607677E+010.2747788E+01
0.3919833E+000.4919006E+000.5804780E+000.6190338E+000.6749774E+00
0.7394890E+000.8828760E+000.1049825E+010.1272968E+010.1454281E+01
0.1718375E+010.1902838E+010.2005023E+01
0.2858920E+000.3588455E+000.4234831E+000.4515809E+000.4924046E+00
0.5394023E+000.6441076E+000.7658228E+000.9286137E+000.1060912E+01
0.1253565E+010.1388005E+010.1462597E+01
0.2085285E+000.2617002E+000.3089499E+000.3294877E+000.3592235E+00
0.3934953E+000.4698508E+000.5586802E+000.6773714E+000.7738867E+00
0.9143758E+000.1012528E+010.1066960E+01
0.1503170E+000.1886206E+000.2225144E+000.2373824E+000.2588022E+00
0.2834980E+000.3385597E+000.4024413E+000.4879947E+000.5575462E+00

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    0.6588495E+000.7295350E+000.7687208E+00
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STARG.DAT

TARGET AIRCRAFT SINGLE PARAMETER DATA

NAME	NEW VALUE	UNIT	DESCRIPTION (DEFAULTS)
TS	65.	M**2	TARGET AIRCRAFT PLANFORM AREA (65.0)
TMXMAC	2.4	M	MAXIMUM MACH NUMBER (2.4)
TGLMIT	9.0	G	LIMIT (9.0)
TFIXWT	10000.0	KG	DRY WEIGHT, NO WEAPONS (27,000)
TFUELW	5000.0	KG	FUEL WEIGHT (10,000)
TPAYWT	400.0	KG	PAYLOAD, WEAPONS WEIGHT (1,200)
TENG	4.	-	NUMBER OF ENGINES (2)
ALTCON	500.0	M	CONSTANT FOR ALTITUDE MATCHING (500.0)
DLTAMC	0.2	M	ADDITIONAL MACH NUMBER TO BE ACHIEVED IN DESCENT PHASE OF DESCENDING DRAG MANEUVER (0.2)
DTLMIT	0.2	SEC	TIME LIMIT TO ROLL OUT TO COMMANDED BANK ANGLE (0.2)
MXWPDD	172.0	DEG/SEC**2	MAX ROLL ACCELERATION FOR PURSUIT MANEUVER (172.0)
MXBNKD	140.0	DEG	BANK ANGLE COMMANDED FOR DESCENDING DRAG DESCENT (140.0)
MAXGEE	5.	G	MAX G TO PULL OUT OF DESCENDING DRAG MANEUVER (5.0)
MAXMAC	10.0	-	MACH USED IN POST PULL OUT/ACCEL OF DESCENDING DRAG (10.0)
MINALT	1000.0	M	MIN ALTITUDE USED IN DESCENDING DRAG MANEUVER (1000.0)
NSUPTD	60.0	DEG	LIMIT TO NOSE UP ATTITUDE PULLING OUT OF DIVE (60.0)
PSSD	100.0	DEG/S	STEADY STATE ROLL RATE (100.0)
TAUR	0.2	SEC	BANK ACCELERATION COMMAND TIME CONSTANT (0.2)
TLTGMN	1.0	G	MIN G TO ACHIEVE DESIRED ALTITUDE (1.0)
TLTGMX	9.0	G	MAX G TO ACHIEVE DESIRED ALTITUDE (9.0)
VLIMIT	50.	M/S	MAX ASCENT/DESCENT RATE TO ACHIEVE DESIRED ALTITUDE (50.0)
WPDLMT	10.0	RAD/SEC**2	ROLL ACCELERATION LIMIT TO ACHIEVE COMMANDED BANK ANGLE (10.0)
MXGTGG	9.0	G	MAX LIFT ACCEL FOR PURSUIT MANEUVER (9.0)
MNGTGG	0.0	G	MIN LIFT ACCEL FOR PURSUIT MANEUVER (0.0)
RDEST	500.0	M	DESIRED RANGE BETWEEN TARGET AND LAUNCH A/C IN PURSUIT MANEUVER (500.0)
RFART	5000.0	M	RANGE RATE>RRDES ALLOWED IF RANGE>RFAR IN PURSUIT MANEUVER (5000.0)
RLNERT	1500.0	M	RANGE RATE DECREASES FROM RRDES TO 0 IF RANGE>RLINER (1500.0)
RRDEST	-50.0	M/S	DESIRED RANGE RATE FOR RANGE>RLINER & RANGE<RFAR (-50.0)
TMCNST	25.0	SEC	TIME CONST FOR REACTING TO AZIMUTH & ELEVATION ERRORS IN PURSUIT (25.0)
DTCONT	0.2	SEC	TIME CONSTANT FOR ROLL COMMANDS IN PURSUIT MANEUVER (0.2)
MCHCNT	20.0	-	CONST FOR MACH CONTROL FOR PURSUIT MANUEVER (20.0)
TGMNAL	500.0	M	MINIMUM ALTITUDE TO CHECK FOR GROUND CLOBBER (500.0)
ACDOTT	0.1	M/S**2	MAX CHANGE IN NORMAL ACCELERATION IN ONE TIME STEP (0.1)

APPENDIX B - MICROPEP INPUTS AND OUTPUTS

TABLE B-1:MICROPEP INPUTS

Propellant Ingredients:	85% AP 15% HTPB (Sinclair Formula)		
Propellant Temp k (°F)	219.3 (-65)	294.3 (70)	338.7 (150)
Chamber pressures (Generic SRAAM) (psi):	786.5	1030.3	1209.0
Chamber Pressures (DIT Variants) (psi):	1315.8	1723.6	2022.0
Exhaust Pressure (psi):	0.067		

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0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&    N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraam-g           * 05/24/93  * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)        -602  0.07040    1CL  4H   1N   4O
 HTPB (SINCLAIR)                    13  0.03320  103H  73C   1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT        (LAST ITEM IN LIST)

    85.0000    15.0000   100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H     1.098706 C     0.723423 N     2.908741 O
    0.723423 CL

 ******************************CHAMBER RESULTS FOLLOW******************************

  T(K)  T(F)  P(ATM)   P(PSI) ENTHALPY  ENTROPY   CP/CV   SGAMMA    RT/V
 2795. 4572.   53.50   786.50   -53.34   243.70  1.2241  1.1928   13.152   TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3529.273 AND 3529.281 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=   10.852   10.852
 NUMBER MOLS GAS AND CONDENSED=   4.0678   0.0000

   1.43108 H2O        0.73592 CO         0.70654 HCl        0.42330 H2
   0.36269 CO2        0.36111 N2         0.01661 Cl         0.01446 H
  1.40E-02 HO        1.13E-03 NO        4.05E-04 O2        2.96E-04 O
  8.44E-05 Cl2       2.92E-05 HOCl      2.11E-05 COCl      1.79E-05 NH3
  1.33E-05 CHO       1.18E-05 OCl       2.98E-06 HO2       2.36E-06 CH2O
  2.10E-06 NH2       1.92E-06 CNH       1.21E-06 NHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.583

 TOTAL HEAT CONTENT (298 REF)    =1140.826 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)= 971.115 CAL/GM

 ******************************EXHAUST RESULTS FOLLOW******************************

  T(K)  T(F)  P(ATM)   P(PSI) ENTHALPY  ENTROPY   CP/CV   SGAMMA    RT/V
  580.  585.    0.00     0.07  -155.35   243.70  1.2991  1.1546   0.001   TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1609.476 AND 1609.480 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    8.630    8.630
```

NUMBER MOLS GAS AND CONDENSED= 3.8400 0.0000

0.97634	CO2	0.93570	H2O	0.72338	HCl	0.72048	H2
3.62E-01	N2	1.02E-01	CH4	2.03E-02	CO	2.57E-05	NH3

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.042

TOTAL HEAT CONTENT (298 REF) = 187.902 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 88.821 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2266 1.2053
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
288.1	1.2260	2519.	30.41	4882.1		334.71	480.6	0.19297	354.	158853.
298.0	1.1988	2549.	30.13	4919.7	189.9	496.32	497.1	0.19446	580.	286398.

**** NEWPEP - Feb. 1990 ****

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0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&     N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraam-g            * 05/24/93   * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)          -602  0.07040    1CL  4H    1N    4O
 HTPB (SINCLAIR)                      13  0.03320  103H  73C    1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT          (LAST ITEM IN LIST)

    85.0000     15.0000    100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H.      1.098706 C      0.723423 N      2.908741 O
    0.723423 CL

 ******************************CHAMBER RESULTS FOLLOW*******************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
 2843.  4658.    70.09  1030.30   -51.08    242.31  1.2237   1.1923    17.225    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3558.857 AND 3558.865 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    10.872    10.872
 NUMBER MOLS GAS AND CONDENSED=     4.0689    0.0000

   1.43221 H2O          0.73840 CO           0.70603 HCl          0.42165 H2
   0.36104 N2           0.36020 CO2          0.01708 Cl           0.01508 HO
  1.49E-02 H           1.27E-03 NO          4.49E-04 O2          3.27E-04 O
  9.72E-05 Cl2         3.56E-05 HOCl        2.70E-05 COCl        2.25E-05 NH3
  1.70E-05 CHO         1.43E-05 OCl         3.77E-06 HO2         3.08E-06 CH2O
  2.73E-06 NH2         2.51E-06 CNH         1.56E-06 NHO         1.33E-06 CNHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.577

 TOTAL HEAT CONTENT (298 REF)    =1162.978 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)= 992.003 CAL/GM

 ******************************EXHAUST RESULTS FOLLOW*******************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
  573.   573.    0.00      0.07  -156.15    242.31  1.2988   1.1540     0.001    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1594.738 AND 1594.741 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=     8.637     8.637
```

NUMBER MOLS GAS AND CONDENSED= 3.8150 0.0000

0.96740 CO2	0.95713 H2O	0.72338 HCl	0.67408 H2
3.62E-01 N2	1.14E-01 CH4	1.68E-02 CO	2.64E-05 NH3

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.212

TOTAL HEAT CONTENT (298 REF) = 187.460 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 86.110 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2260 1.2045
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
292.0	1.2261	2562.	39.85	4923.8		409.11	487.1	0.14857	338.	152523.
302.4	1.1977	2594.	39.48	4963.7	191.6	623.56	504.4	0.14977	573.	285616.

**** NEWPEP - Feb. 1990 ****

0BOOST VELOCITIES FOR PROPELLANT DENSITY OF 0.06027 (S.G. OF 1.668)

5./29998.	10./23690.	15./20162.	25./15976.	30./14572.	55./10337.	
60./ 9792.	69./ 8951.	71./ 8785.	88./ 7598.	100./ 6944.	150./ 5130.	
175./4543.	200./4079.	300./2899.	1000./ 964.	3000./ 332.	5000./ 201.	

0 EXP. RATIO	EXIT PRESS ATM	EXIT PRESS SI	EXIT TEMP K	OPTIMUM IMPULSE SEC	OPTIMUM IMPULSE SI	VACUUM IMPULS SEC	VACUUM IMPULS SI	SEA LV IMPULS SEC	SEA LV IMPULS SI
1.	39.479	3999.3	2594.	104.7	1027.	191.6	1879.	189.4	1857.
2.	13.160	1333.1	2161.	169.0	1657.	226.9	2225.	222.5	2182.
3.	4.603	466.3	1814.	206.3	2023.	236.7	2321.	230.1	2256.
4.	3.046	308.5	1693.	217.7	2135.	244.5	2397.	235.7	2311.
5.	2.229	225.8	1608.	225.4	2210.	249.9	2451.	238.9	2343.
6.	1.734	175.7	1542.	231.2	2267.	254.1	2491.	240.9	2362.
7.	1.406	142.4	1489.	235.7	2311.	257.4	2524.	241.9	2373.
8.	1.174	118.9	1445.	239.4	2347.	260.1	2550.	242.4	2377.
9.	1.002	101.5	1407.	242.5	2378.	262.3	2572.	242.5	2378.
10.	0.871	88.2	1375.	245.1	2404.	264.3	2592.	242.3	2376.
11.	0.767	77.7	1346.	247.4	2427.	266.0	2609.	241.8	2371.
12.	0.684	69.3	1321.	249.5	2447.	267.5	2624.	241.1	2365.
13.	0.615	62.3	1298.	251.3	2464.	268.9	2637.	240.3	2356.
14.	0.558	56.5	1277.	253.0	2480.	270.1	2649.	239.3	2347.
15.	0.510	51.6	1258.	254.4	2495.	271.3	2660.	238.3	2336.
16.	0.468	47.5	1240.	255.8	2508.	272.3	2670.	237.1	2325.
17.	0.433	43.8	1224.	257.1	2521.	273.2	2680.	235.8	2313.
18.	0.402	40.7	1209.	258.2	2532.	274.1	2688.	234.5	2300.
19.	0.374	37.9	1195.	259.3	2543.	274.9	2696.	233.1	2286.
20.	0.350	35.5	1181.	260.3	2552.	275.7	2704.	231.7	2272.
21.	0.329	33.3	1169.	261.2	2562.	276.4	2711.	230.2	2257.
22.	0.309	31.3	1157.	262.1	2570.	277.1	2717.	228.7	2242.
23.	0.292	29.6	1146.	262.9	2578.	277.7	2723.	227.1	2227.
24.	0.276	28.0	1136.	263.7	2586.	278.3	2729.	225.5	2211.
25.	0.262	26.6	1126.	264.5	2593.	278.9	2735.	223.9	2195.

1

0 EXP. RATIO	EXIT PRESS ATM	EXIT PRESS SI	EXIT TEMP K	OPTIMUM IMPULSE SEC	OPTIMUM IMPULSE SI	VACUUM IMPULS SEC	VACUUM IMPULS SI	SEA LV IMPULS SEC	SEA LV IMPULS SI
26.	0.249	25.3	1116.	265.2	2600.	279.4	2740.	222.2	2179.

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0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&    N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraam-g             * 05/24/93  * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)          -602  0.07040    1CL  4H    1N    4O
 HTPB (SINCLAIR)                      13  0.03320  103H  73C    1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT         (LAST ITEM IN LIST)

    85.0000     15.0000    100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H      1.098706 C      0.723423 N      2.908741 O
    0.723423 CL

 ****************************CHAMBER RESULTS FOLLOW*****************************

  T(K)  T(F)  P(ATM)   P(PSI) ENTHALPY  ENTROPY   CP/CV   SGAMMA    RT/V
 2871. 4708.   82.24  1209.00   -49.75   241.49  1.2234  1.1921   20.209    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3576.218 AND 3576.227 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=   10.883   10.883
 NUMBER MOLS GAS AND CONDENSED=   4.0695   0.0000

   1.43284 H2O        0.73980 CO         0.70578 HCl        0.42073 H2
   0.36099 N2         0.35878 CO2        0.01731 Cl         0.01570 HO
  1.51E-02 H         1.36E-03 NO        4.74E-04 O2        3.45E-04 O
  1.05E-04 Cl2       3.98E-05 HOCl      3.12E-05 COCl      2.58E-05 NH3
  1.96E-05 CHO       1.60E-05 OCl       4.30E-06 HO2       3.60E-06 CH2O
  3.18E-06 NH2       2.95E-06 CNH       1.80E-06 NHO       1.57E-06 CNHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.573

 TOTAL HEAT CONTENT (298 REF)   =1175.691 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)=1004.383 CAL/GM

 ****************************EXHAUST RESULTS FOLLOW*****************************

  T(K)  T(F)  P(ATM)   P(PSI) ENTHALPY  ENTROPY   CP/CV   SGAMMA    RT/V
  570.  566.    0.00     0.07  -156.62   241.49  1.2985  1.1305   0.001    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1585.410 AND 1586.063 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    8.636    8.628
```

NUMBER MOLS GAS AND CONDENSED= 3.7995 0.0068

0.97735 H2O	0.95821 CO2	0.72338 HCl	0.64522 H2
0.36167 N2	0.11881 CH4	0.01470 CO	0.00682 C&
2.67E-05 NH3			

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.272

TOTAL HEAT CONTENT (298 REF) = 188.241 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 84.750 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2257 1.2041
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
294.3	1.2257	2587.	46.77	4949.3		460.68	490.9	0.12727	328.	148814.
305.0	1.1973	2620.	46.34	4989.1	192.6	714.14	508.8	0.12829	570.	285097.

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0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&    N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraamdit           * 05/28/93  * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)          -602  0.07040    1CL  4H    1N    4O
 HTPB (SINCLAIR)                      13  0.03320  103H  73C    1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT         (LAST ITEM IN LIST)

    85.0000     15.0000    100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H      1.098706 C      0.723423 N      2.908741 O
    0.723423 CL

 ****************************CHAMBER RESULTS FOLLOW*****************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
 2808.  4595.    89.51   1315.80   -53.34   239.54  1.2237   1.1974    22.029    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3534.389 AND 3534.397 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=   10.870   10.870
 NUMBER MOLS GAS AND CONDENSED=    4.0632   0.0000

   1.43376 H2O          0.73548 CO           0.70966 HCl          0.42171 H2
   0.36311 CO2          0.36120 N2           0.01347 Cl           0.01165 H
  1.15E-02 HO          9.41E-04 NO          2.69E-04 O2          1.96E-04 O
  8.87E-05 Cl2         3.11E-05 HOCl        2.96E-05 NH3         2.83E-05 COCl
  1.77E-05 CHO         1.00E-05 OCl         3.93E-06 CH2O        3.20E-06 CNH
  2.80E-06 NH2         2.56E-06 HO2         1.67E-06 CNHO        1.30E-06 NHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.611

 TOTAL HEAT CONTENT (298 REF)   =1143.053 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)= 976.348 CAL/GM

 ****************************EXHAUST RESULTS FOLLOW*****************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
  561.   550.     0.00      0.07  -157.72   239.54  1.2980   1.1301     0.001    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1563.588 AND 1565.790 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    8.632    8.603
```

NUMBER MOLS GAS AND CONDENSED= 3.7645 0.0233

1.02500 H2O	0.93646 CO2	0.72338 HCl	0.57901 H2
0.36167 N2	0.12809 CH4	0.02334 C&	0.01075 CO
2.73E-05 NH3			

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.400

TOTAL HEAT CONTENT (298 REF) = 189.899 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 81.362 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2264 1.2088
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
290.9	1.2271	2528.	50.78	4889.1		487.22	485.2	0.11551	312.	141060.
301.4	1.2026	2555.	50.35	4922.5	190.1	777.14	502.8	0.11630	561.	280224.

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0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&     N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraamdit          * 05/28/93  * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)          -602  0.07040    1CL  4H   1N   4O
 HTPB (SINCLAIR)                      13  0.03320  103H  73C   1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT         (LAST ITEM IN LIST)

    85.0000     15.0000    100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H      1.098706 C      0.723423 N      2.908741 O
    0.723423 CL

 ****************************CHAMBER RESULTS FOLLOW*****************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY    CP/CV    SGAMMA     RT/V
 2856.  4681.   117.25   1723.60   -51.09   238.15   1.2232   1.1968    28.849    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3564.090 AND 3564.099 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    10.890    10.890
 NUMBER MOLS GAS AND CONDENSED=    4.0641    0.0000

   1.43507 H2O          0.73788 CO           0.70923 HCl          0.41998 H2
   0.36114 N2           0.36069 CO2          0.01386 Cl           0.01236 HO
  1.20E-02 H           1.06E-03 NO          2.99E-04 O2          2.17E-04 O
  1.02E-04 Cl2         3.78E-05 HOCl        3.71E-05 NH3         3.61E-05 COCl
  2.26E-05 CHO         1.22E-05 OCl         5.12E-06 CH2O        4.18E-06 CNH
  3.64E-06 NH2         3.24E-06 HO2         2.22E-06 CNHO        1.67E-06 NHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.606

 TOTAL HEAT CONTENT (298 REF)    =1164.991 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)= 997.471 CAL/GM

 ****************************EXHAUST RESULTS FOLLOW*****************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY    CP/CV    SGAMMA     RT/V
  554.   538.     0.00      0.07  -158.49   238.15   1.2976   1.1299     0.001    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1547.999 AND 1551.261 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    8.628     8.583
```

NUMBER MOLS GAS AND CONDENSED= 3.7400 0.0349

1.05879 H2O	0.92069 CO2	0.72338 HCl	0.53230 H2
0.36167 N2	0.13455 CH4	0.03489 C&	0.00850 CO
2.76E-05 NH3			

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.491

TOTAL HEAT CONTENT (298 REF) = 191.014 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 78.899 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2258 1.2079
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
294.7	1.2253	2573.	66.51	4933.1		595.41	491.6	0.08898	298.	135291.
305.8	1.2019	2600.	66.01	4965.9	191.8	976.67	510.0	0.08957	554.	278991.

**** NEWPEP - Feb. 1990 ****

```
0COMPLETE SPECIES LIST FOLLOWS
 C        CCl      CNCl     COCl2    CCl4     CH       CHCl3    CNH
 CNHO     CHO      CH2      CH2Cl2   CH2O     CH3      CH3Cl    CH4
 CN       CO       CO2      C2       C2H2     C2H4     C2H4O    C2N2
 C3       C3O2     C4       C4N2     C5       Cl       HCl      HOCl
 NOCl     OCl      O2Cl     Cl2      OCl2     H        NH       HO
 H2       NH2      H2O      H2O2     NH3      N2H4     N        NO
 NO2      N2       N2O      N2O3     N2O4     N2O5     O        O2
 O3       COCl     NO2Cl    NHO      NHO2     NHO2     NHO3     HO2
 NO3      CCl2     CCl3     N2H2     CN2      CN2      C2O      C2H
 C2N      C2Cl4    C2Cl6    C2Cl2    C2HCl    CHCl     CNO      N3
 C&       NH4Cl&   NH4Cl&   NH4O4Cl&N2O4&     N2O4*    N2H4*    H2O*
 H2O*
1                          **** NEWPEP - Feb.  1990 ****
 * sraamdit           * 05/28/93  * DH ** DENS **** COMPOSITION *******

 AMMONIUM PERCHLORATE (AP)          -602  0.07040    1CL  4H    1N    4O
 HTPB (SINCLAIR)                      13  0.03320  103H  73C    1O

 INGREDIENT WEIGHTS (IN ORDER) AND TOTAL WEIGHT         (LAST ITEM IN LIST)

    85.0000     15.0000    100.0000

 THE PROPELLANT DENSITY IS 0.06027 LB/CU-IN OR  1.6683 GM/CC

 NUMBER OF GRAM ATOMS OF EACH ELEMENT PRESENT IN INGREDIENTS

    4.443920 H      1.098706 C      0.723423 N      2.908741 O
    0.723423 CL

 ******************************CHAMBER RESULTS FOLLOW*******************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
 2884.  4732.   137.54  2022.00   -49.75   237.33  1.2229   1.1966    33.840    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 3581.566 AND 3581.575 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=    10.902    10.902
 NUMBER MOLS GAS AND CONDENSED=    4.0646    0.0000

   1.43580 H2O         0.73924 CO          0.70900 HCl         0.41900 H2
   0.36110 N2          0.35932 CO2         0.01406 Cl          0.01288 HO
  1.21E-02 H          1.13E-03 NO         3.16E-04 O2         2.29E-04 O
  1.11E-04 Cl2        4.25E-05 NH3        4.24E-05 HOCl       4.17E-05 COCl
  2.61E-05 CHO        1.36E-05 OCl        5.99E-06 CH2O       4.89E-06 CNH
  4.25E-06 NH2        3.70E-06 HO2        2.63E-06 CNHO       1.93E-06 NHO

 THE MOLECULAR WEIGHT OF THE MIXTURE IS   24.603

 TOTAL HEAT CONTENT (298 REF)    =1177.833 CAL/GM
 SENSIBLE HEAT CONTENT (298 REF)=1010.015 CAL/GM

 ******************************EXHAUST RESULTS FOLLOW*******************************

  T(K)   T(F)   P(ATM)    P(PSI) ENTHALPY  ENTROPY   CP/CV    SGAMMA     RT/V
  550.   531.     0.00     0.07  -158.95   237.33  1.2975   1.1299     0.001    TCRE

 DAMPED AND UNDAMPED SPEED OF SOUND= 1538.674 AND 1542.555 FT/SEC

 SPECIFIC HEAT (MOLAR) OF GAS AND TOTAL=     8.624     8.571
```

NUMBER MOLS GAS AND CONDENSED= 3.7256 0.0417

1.07887 H2O	0.91122 CO2	0.72338 HCl	0.50467 H2
0.36167 N2	0.13833 CH4	0.04174 C&	0.00736 CO
2.77E-05 NH3			

THE MOLECULAR WEIGHT OF THE MIXTURE IS 26.544

TOTAL HEAT CONTENT (298 REF) = 191.660 CAL/GM
SENSIBLE HEAT CONTENT (298 REF)= 77.418 CAL/GM

**********PERFORMANCE: FROZEN ON FIRST LINE, SHIFTING ON SECOND LINE**********

An exact method for determining throat conditions was used
The frozen & shifting STATE gammas for the throat are: 1.2254 1.2076
ISentropic EXponent shown below is the gamma for the chamber to throat PROCESS.

IMPULSE	IS EX	T*	P*	C*	ISP*	OPT EX	D-ISP	A*M.	EX T	ADH
296.9	1.2250	2599.	7P.03	4958.3		670.53	495.3	0.07623	289.	131938.
308.3	1.2015	2626.	77.40	4991.4	192.71	118.01	514.3	0.07674	550.	278099.

**** NEWPEP - Feb. 1990 ****

APPENDIX C - ROCKET INPUTS

1 motor 1 stage 1 (50/50)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	585.8
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600. .000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.3200
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	532.900
.150	532.900
.250	532.900
.400	532.900
.600	532.900
.785	532.900
.857	501.000
.948	446.000
.982	323.000
1.020	114.000

1 motor 1 stage 2 (50/50)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	1171.6
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600. .000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.3200
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	532.900
.150	532.900
.250	532.900
.400	532.900
.600	532.900
.785	532.900
.857	501.000
.948	446.000
.982	323.000
1.020	114.000

1 motor 2 stage 1 (60/40)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	703.0
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600.	.000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.2670
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	639.400
.150	639.400
.250	639.400
.400	639.400
.600	639.400
.785	639.400
.857	601.100
.948	535.200
.982	387.500
1.020	136.700

1 motor 2 stage 2 (60/40)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	1171.6
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600.	.000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.3750
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	426.300
.150	426.300
.250	426.300
.400	426.300
.600	426.300
.785	426.300
.857	400.700
.948	356.800
.982	258.300
1.020	91.100

1 motor 3 stage 1 (67/33)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	781.1
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600. .000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.2410
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	710.500
.150	710.500
.250	710.500
.400	710.500
.600	710.500
.785	710.500
.857	667.900
.948	594.700
.982	430.600
1.020	151.800

1 motor 3 stage 2 (67/33)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	1171.6
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600.	.000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.4000
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	358.900
.150	358.900
.250	358.900
.400	358.900
.600	358.900
.785	358.900
.857	337.400
.948	300.400
.982	217.500
1.020	76.700

1 motor 4 stage 1 (70/30)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	816.0
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600. .000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.2300
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	742.300
.150	742.300
.250	742.300
.400	742.300
.600	742.300
.785	742.300
.857	687.800
.948	621.300
.982	449.900
1.020	158.600

1 motor 4 stage 2 (70/30)

Motor Performance Program IBM-PC Version 1.0
INPUT DATA...

General Configuration PARAMETERS are ...

Throat AREA	1.0678
Exit AREA	17.5301
Expansion RATIO	16.4170
Total Motor VOLUME (in^3)	1171.6
AMBIENT Temperature (°F)	70.0
AMBIENT Pressure (psi)	.0
Closure BLOWOUT (psi)	35.0
Pzero (psi)	14.7
Lambda	1.0000
Cd	.9386
Gamma	1.2261
Throat DESIGN Pressur (psi)	1720.0
THROAT EROS. DELAY TI (s)	10.000

PRESSURE (psi) VS. THROAT EROSION RATE

600. .000000

DESCRIPTION OF GRAIN 1

BURN RATE (in/s)	.4000
BURN RATE EXP.	.3000
PI SUB K	.2000
BURN REF. PRESS.(psi)	1030.3
CHAR. EXHAUST VEL. (ft/s)	4855.6
C STAR EXP.	.0327
DENSITY (lbm/in^3)	.0603
IGNITION TIME	.0000
DELTA IGN. TIME	.0000

WEB (in)	BURN AREA (in^2)
.000	326.300
.150	326.300
.250	326.300
.400	326.300
.600	326.300
.785	326.300
.857	306.700
.948	273.100
.982	197.700
1.020	69.700

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